Concrete

Vol. 27 Chicago, September, 1925 No. 3

The Dawn of a New Age

The day of carelessness and deliberate skimping on public work is drawing to a close. A new day is dawning—a day when men will undertake public work with the full determination to do their best—to deliver an honest job honestly done, for a profit that is entirely in line with the profits to be derived for construction undertaken for private owners. The old order of haste, waste, and profiteering is passing. The contractor knows that poor work, while immediately profitable, builds but an indifferent reputation for him, and gets him little future work. He is listening to the engineers, and giving thought to the public welfare—and is finding good work more profitable than he had hitherto suspected.

Witness the story about Chicago's Wacker Drive, in this issue. Without the active co-operation of the contractor, all the trouble, all the experience, all the knowledge, all the work of the engineers might have gone for naught. Because of the fact that the contractor is doing his share, the taxpayers of the city are getting a fair break. It seems that the old sort of contractor is soon to join the ranks of the late but not lamented dodo. Let us shed a tear upon his grave and go our way rejoicing.

This Is Healthy Competition

Records are being made and broken every day in the construction world, records for speed in erecting steel, records for speed in placing concrete, and all sorts of other records, including the record wages paid and the record prices paid for some materials—sometimes. The work of the world demands speed in the erection of buildings that are to house our activities and in the construction of the roads and streets that are to transport people and goods from place to place. All speed performs a real service to the community, and to the man who makes the speed, as long as quality of workmanship does not suffer thereby. The most beneficial sort of competition is the competition of speed and service. The men who built the Kansas City plant for Sears, Roebuck & Co., the men who are building Wacker Drive, the men who added one story to a California garage, as will be told in these pages, and the men who poured 1,865 cubic yards of concrete on June 9 during the construction of the new South Water market in Chicago, all were striving to make and break records, and were thus serving the industry. While the latter record seems to be the best, on ordinary portland cement concrete work, at this writing, no doubt we shall hear of other records before we go to press. Although it seems not to matter greatly WHO makes the records, yet it is of prime importance that the records are being MADE. Let us hope that they may not be ESTABLISHED.

Real Progress in Highway Research

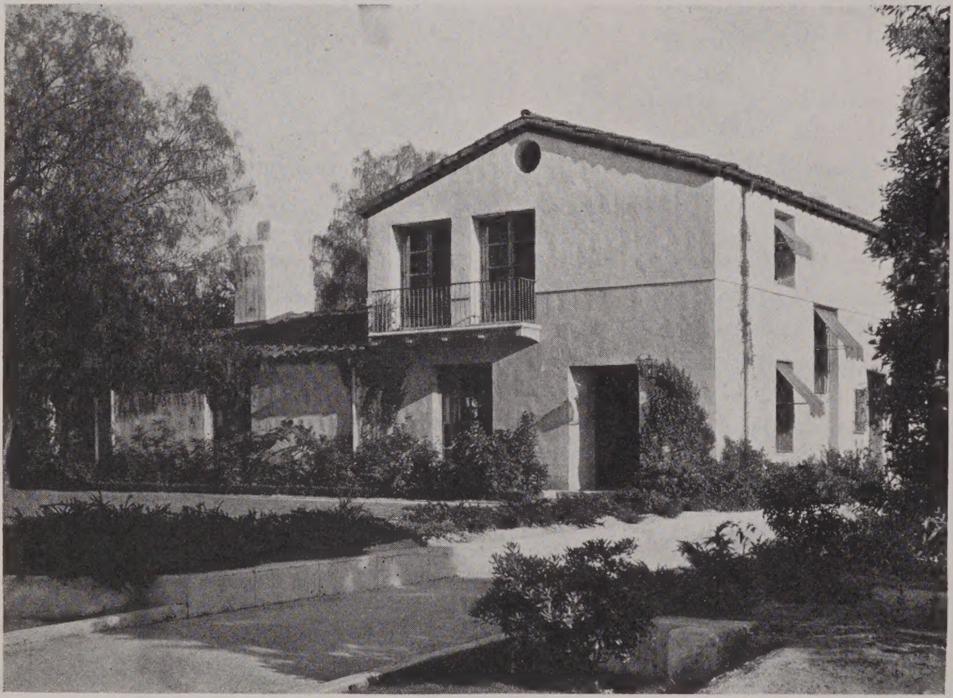
The engineers who are studying problems concerning highway location, construction, and maintenance are getting somewhere. Papers by A. T. Goldbeck in this and other issues give an indication of what is actually being dones. It seems that we shall soon actually be able to build concrete roads that will deliver in practice what our engineers believe they should do in theory. Perhaps we are able to achieve this great result today, but we shall know more as time goes on. At least we can say, without fear of contradiction, that we know how to build roads that are far better than any that have been built in the recent past. Given an honest job of construction, we know that concrete highways can be provided to meet any conditions of traffic that they may be called upon to face.

Make Fire Prevention Week Successful

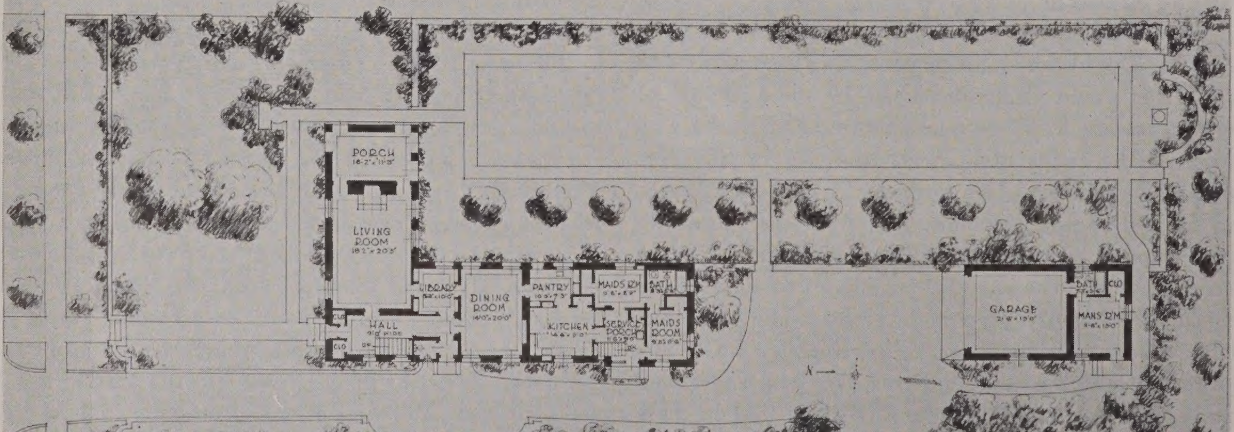
Next month will see an event of importance to us all. Fire Prevention Week, scheduled for October 4 to 10, will be observed in every city, in every town, in every hamlet in this great nation of ours. It will be devoted to selling the public on the idea of fire prevention. It will be used to educate people along the lines of better construction. Every man interested in the erection of concrete buildings, whether they be small homes or altitudinous skyscrapers, will render a real service to his community and to himself if he places his experience, his knowledge, his talents, at the disposal of the community during that week. Get on the bandwagon. Help out your local committees as much as you can if your town is planning a special program for the week. Show the people what concrete can do for them while they are thinking of fire prevention and the reduction of fire losses. Do it now, and then get the habit.

Residence of Dr. W. Humes Roberts, Pasadena, Calif.

Myron Hunt, Architect



The illustrations show something of the attractiveness of the residence of Dr. W. Humes Roberts, 1370 California street, Pasadena, Cal.; Myron Hunt, architect, 1107 Hibernia Bldg., Los Angeles. The house, garage and garden walls are of concrete, built by the Johnson Hollow Wall System consisting of two 4-inch walls with an air space between. Most of the construction had a 12-inch air space, making the wall 20 inches thick over all. Mr. Hunt has done considerable very interesting work with this construction, some of it having been described in detail in an article by Mr. Hunt in Concrete *for March, 1925.*

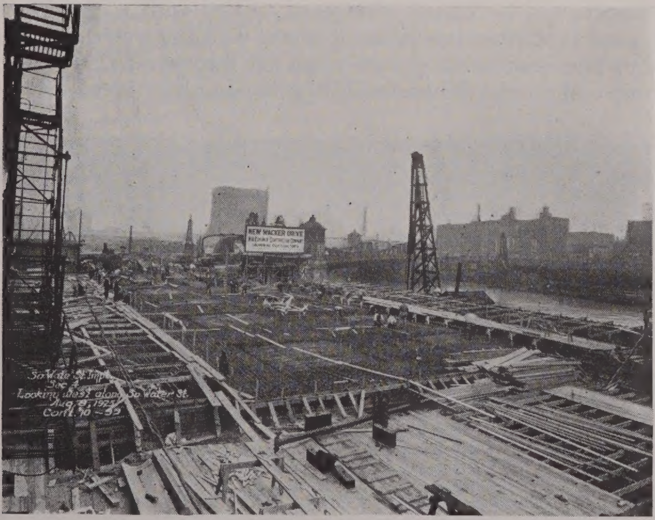


Inundation Used on Wacker Drive

Scientific Methods Insure High Class Concrete on $9,000,000 Project in Chicago

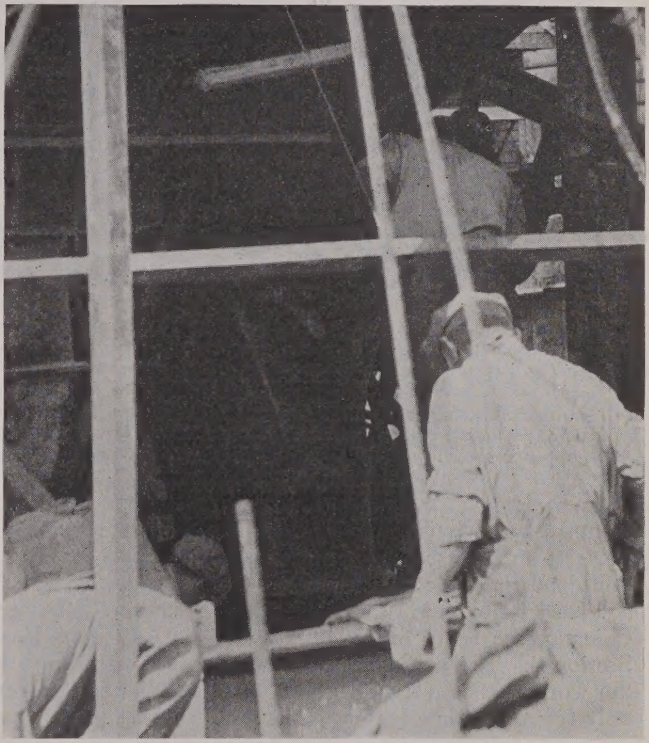
We have heard a lot of talk about putting science to work to insure perfect results on actual concreting operations, and we have heard a lot of talk about getting the contractor to work along with the engineer, to the end that the building public might have something to show for the money spent. Here is an actual instance, on a large scale, where some real concrete is being placed on public work, where politics stays off the job, and where the cost is proving far below the first estimate of the engineers who planned the extensive and expensive improvement. Incidently, it seems to clinch the argument for that new sand-measuring idea, the inundation process, described by Slater and Bertin before the convention of the American Concrete Institute in 1923.

The City of Chicago is spending some $25,000,000 to turn a hazardous and rat-infested section of the river-front into an imposing boulevard. It has meant the wiping out of the wholesale provision section of the thriving business district, and replacing the fire-dangerous and dilapidated buildings with new construction that will add greatly to the progress of the city. Part of this work consists of the building of a huge double-decked thoroughfare along the river from Michigan Avenue to Madison Street, at the total cost of almost nine million dollars. The rest of the money has been spent on obtaining the necessary land, wrecking old buildings, raising grades, and taking care of a lot of things that were not included in the nine million dollars mentioned above.



Here is Section 4 ready for the first half block pour that established a record that was broken on the next half block. One of the mixing plants is behind the sign. The steel is almost all in place.

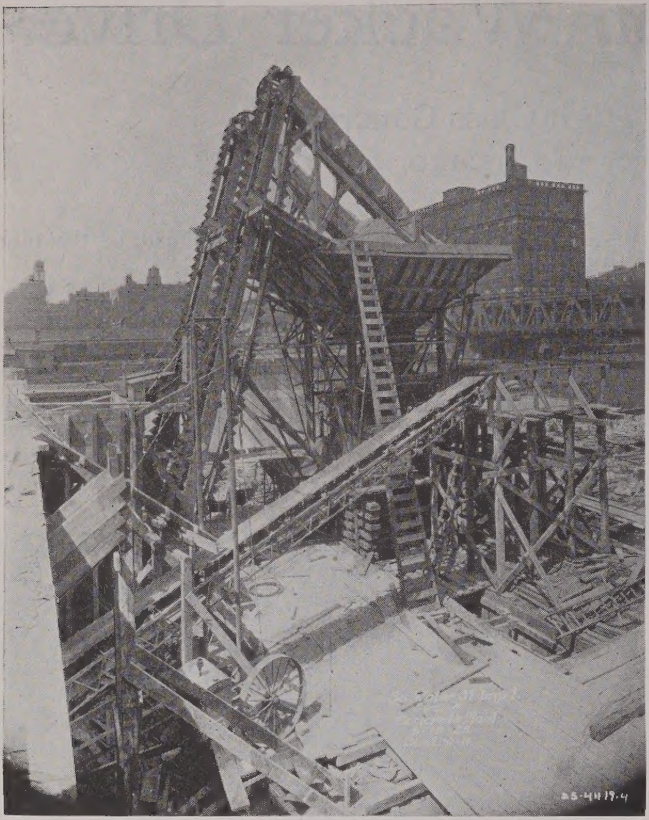
When the work was to be planned the Board of Local Improvements, who took care of the planning of the project, called upon A. R. Lord to act as consulting engineer on design and construction and work with them to the end that the very best sort of concrete work might be obtained. The first thing decided upon was that the best sort of a job that science could obtain would be insisted upon, regardless of political influences and entanglements that might ordinarily prevent the best work. With the aid of the administration, the engineers were able to enforce strict policies to control the performance of the contracts. In writing the specifications for the work the best of methods and the best of materials were specified, and unusually strict safeguards were thrown about the work. Complete laboratory control was planned and put into operation, specifications of the American Society for Testing Materials and other authoritative bodies were adopted, and the best engineering practice was set as a standard. Strict adherence to the correct water-cement ratio was insisted upon, and accurate proportioning was called for.



The inundator is taking on a charge of sand, and when full will swing over to the left and dump its contents into the mixer.

Contract Split into Sections

The project was too large to handle under one general contract, so it was split up into sections, each section being approximately a block or so in length, and conform-



This is the concrete plant located at Franklin Street and Wacker Drive. It consists of a 120-ton material bin divided for stone and sand, a 1-cubic-yard concrete mixer, a stone batcher and inundator, belt conveyors, 55 feet long, and bucket elevators. Trucks back up to the small material hoppers and dump both sand and stone, from which hoppers the material is fed onto the belt conveyors. A two-way hopper is shown in the foreground, for receiving concrete. The cement platform is built of wood.

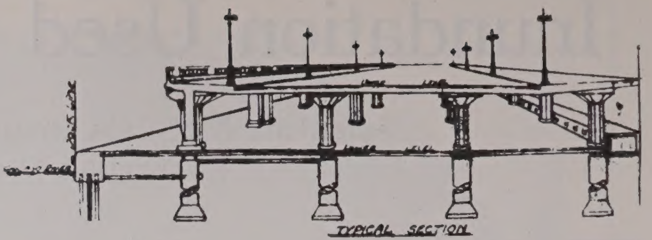
ing to natural divisions of the project. Separate contracts were let on each section. The present part under construction comprises Sections 4 and 5a, and 10 and 11, which has been let to the Mid-Continent Construction Company, Chicago, the same firm that has successfully completed Section 3. The work on these sections, now going on, is the work that is attracting a great deal of attention, not only from the general public but from engineers and constructors as well. It is upon this portion of the work that the scientific methods may be seen in full play, producing an unusually dense and strong concrete at a low cost.

The first thing that a visitor notices when he visits the work is the unusually smooth, dense, and well finished appearance of the concrete from which the forms have been stripped. Every line is true, every surface plane, and every column just as designed, yet the board marks show that practically no patching was done. In fact, the form work and the puddling had to be perfect so that this sort of a result could be obtained without extensive patching, according to the specifications.

The experienced constructor would be greatly interested to know just how this could be done, on city work, and would lose no time in getting up on the upper level to find out.

Real Engineers on the Job

Here, if the day were one on which a great amount of concrete was being poured, he would find as a presiding genius an engineer for the Board of Local Improvements, with a watchful eye on everything going on about him.



This is a typical cross section of the substructure and superstructure of the improvement now under construction. Twelve blocks of this work is included in Wacker Drive.

This man would not be the rough and ready type of inspector so often seen on public work, but would be one of those serious minded and experienced men of technical training, perhaps wearing the badge of the American Society of Civil Engineers on his coat lapel, the sort of man who would always insist on sticking to specifications and the rules of the game, no matter what the cost to the contractor.

The visitor would find this busy watcher glad to take him around the work and tell him just how such good concrete was being made. First he would be taken to the engineers' office on the job where the specifications would be produced and the rules of the work shown. These specifications alone are really worth seeing, but space forbids the reproduction of even a part of them here. They might be called a model set, written by men who knew what was good and insisted upon the best.

An Efficient Mixing Plant

Then to the nearest concreting plant, a model of its kind. Here the aggregates are dumped into hoppers, from which they are retrieved by two bucket elevators and placed into overhead bins; one for the stone and one for the sand. 120 tons of aggregate can be stored in these bins without crowding. The stone bin feeds into a batcher that lets just the right amount of stone into the mixer, while the sand drops into an inundator, which measures this fine aggregate and deposits it into the mixer. This inundator is a new device recently perfected for this work by the Blaw-Knox Co. (there are five of them on duty at this one job), and has been worked up from the ideas incorporated in the device patented by R. L. Bertin. The inundator is suspended from the bottom of the sand bin. It is a metal drum of fixed volume, adjustable to meet requirements, which is partly filled with water. When sand is let into the device it mixes with the water and fills up the inundation chamber, giving the required true volume of sand. When the filling is complete the supply of

These test cylinders are being formed, and will be broken at seven and twenty-eight days to check up on what the contractor is delivering.

This is a view of the formwork at the extreme west of Section 3, near Franklin Street. The last batch of concrete is here being poured on that section.

sand is shut off and the inundator rotated on its trunnions by means of a lever, dumping the inundated sand into the charging chute of the mixer. The additional guaging water is then let into the drum and the mixing begun.

Cement Handled by Conveyor

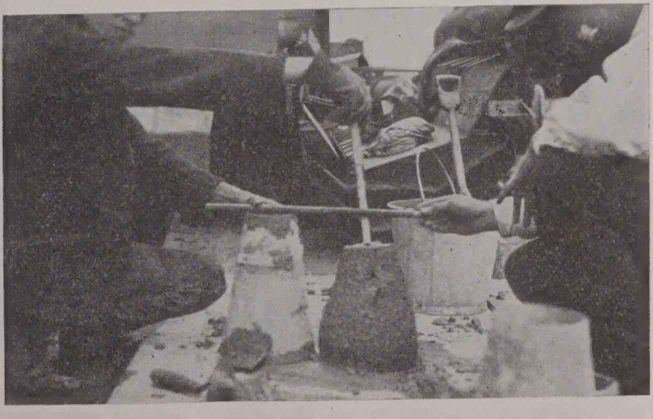
Cement is stored in sacks on the lower level .and is delivered to the charging platform by means of a portable belt conveyor. After the full minute and a half mixing time has elapsed, the one yard batch is discharged into a hopper, fed onto a belt conveyor, elevated to the upper level, dumped into another hopper, and is then taken to the forms in ordinary concrete carts.

There are two mixing plants used at a time. The second plant discharges its batch into a hopper, which delivers the concrete directly into carts. These carts then transport the mix some distance on the lower level to a hod hoist, by which they are lifted to the upper level and from there to the forms.

Each mixing plant utilizes the services of 16 men, and is presided over by an inspector who watches every operation of proportioning and mixing. Four men handle the cement, one man is on the feeding hopper, one man is operating the inundator, one man operates the stone batcher, one man runs the mixer, three men see that the concrete starts its ride up the conveyor, one man lets the concrete into the buggies, six men are at cement storage and loading the sacks on the conveyor, and an engineer keeps the machinery going. This looks at first sight like too much of an organization, but the contractor will always prove to the curious visitor that every man is needed when such great quantities of concrete are to be poured.

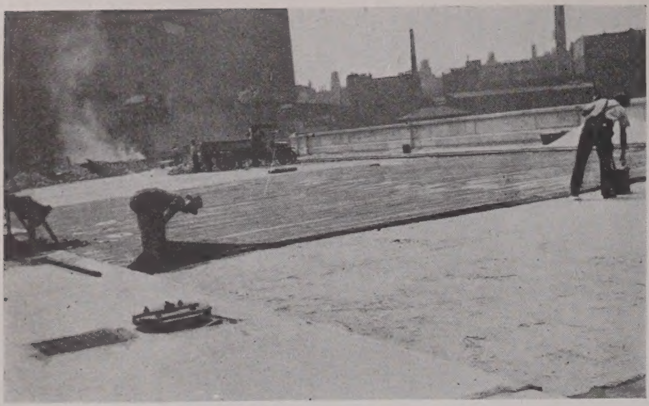
Samples Go to Laboratory

When the concrete is about to be poured from the carts into the forms, the visitor will frequently notice a young man stop one of the carts and extract a bucket full of the mix. When this man, he is one of the corps of numerous inspectors, is followed, the visitor will see him retire to a corner of the job with his sample, where cylinder molds and a slump cone are waiting for use. Part of this portion of concrete is tamped into the standard slump cone, the cone pulled away, and the slump measured. The engineer in charge of these tests will explain that a slump of 3 to 4 inches is considered good, but if the concrete shows up too wet the mixer crew is warned to cut down on the water, for the strength is being endangered. At this field testing station other inspectors are making test cylinders from the sample of concrete, and these cylinders are sent to the two testing laboratories operated by the city for the seven and twenty-eight day compression tests. It has been found by means of these cylinders that the concrete being placed on this work is proving unusually uniform, thanks to the inundator, and that it is giving 28-day strengths of an average of 5,000 pounds on the 1:3½ concrete and 4,000 pounds on the 1:6 batches. This concrete, when dry, has been found to average in weight over 150 pounds a cubic foot.



This is the sort of concrete that is being made on the job. Slumps like this will usually indicate a high strength of concrete, as the water content is about right.

Cement is taken from storage under the completed structure and delivered to the mixer on the upper level by means of this belt conveyor.



When the concrete has fully set, the subgrade of the upper level is covered with this waterproofing and then paved with asphalt.

Not only are these tests made constantly during any run, but the aggregates and the cement have all been tested in the laboratory before delivery to the job. The cement all comes from the Buffington plant of the Universal Portland Cement Company, and is stored in special sealed bins at the plant for the use of this particular job. The cement is sampled as it passes over the conveyor to these bins, and is thus accepted or rejected before delivery is made.

Sand and stone are sampled at the source, and gradings are known in plenty of time to adjust the proportions at the mixer. The new system of designation of proportions is used in the specifications so that the desired proportions of sand and stone can be adjusted on the job to suit the run of the supply. Thus; 1:6 is nominated instead of the old familiar 1:2:4. This is a growing practice, and no doubt will soon be used on all important work.

What the Engineers Desire

By means of these tests the first of the two aims of the engineers is assured—to get the strongest and densest concrete possible with the greatest economy of materials. Other factors that contribute to the success of the mixes used is the fact that spading is carefully and thoroughly done, and is checked constantly by means of a special group of inspectors. These men go prodding around into all corners of the newly deposited concrete and soon see that voids or air pockets are removed by the spading gang. All coarse aggregate is worked well away from the forms, and honeycombing is prevented. This extra care is all the more important because of the great amount of steel that is called for by the design.

Here are to be seen the columns, capitals, drop heads, and slab forms under erection on Section 3, now completed.

The second important aim of the engineers, the visitor is told, is to keep all steel at least an inch away from the surface of the concrete. To do this requires accurate cutting and bending of the bars, and the use of pre-cast concrete units, 6x6 and as long as necessary, to hold the bars at their required levels. Placing of these bars is carefully supervised, and great care is taken during pouring to see that none is displaced.

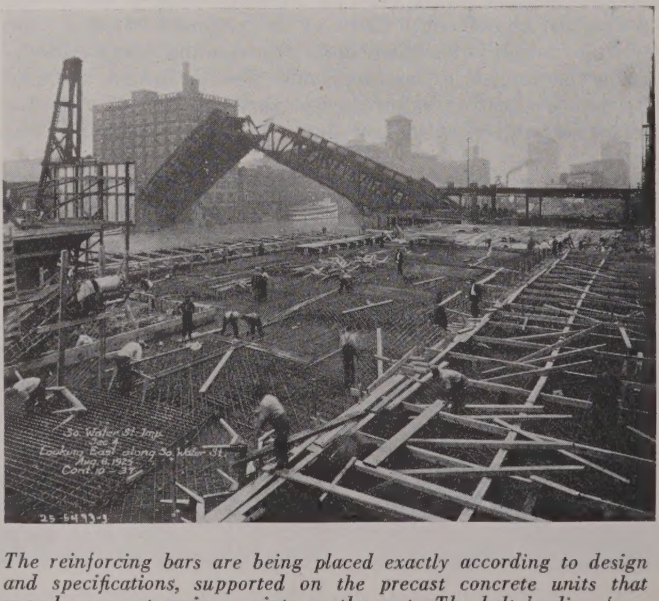
After concrete is poured it is covered with an inch or so of sand, and this protective covering is kept wetted down night and day until the curing process is completed. Eight pounds of hydrated lime is allowed per sack of cement except in cold weather, when no admixture is permitted to be used.

Protecting Concrete in Winter

The cold weather part of the job will be given complete protection. Water will be heated by steam jets, while the sand and gravel will be kept at a high temperature. On the winter work done last year an eighty horsepower boiler was used to furnish steam to perforated coils placed in the bottom of the bin, for heating the sand and the stone. A 500-gallon capacity storage water tank was installed in the boiler room, into which steam jets from the boiler were inserted for heating the water. This heating arrangement enabled the contractor to deposit concrete in the forms at a temperature of 100 degrees Fahrenheit while the outside temperature, on more than one occasion, was below zero. After the concrete was placed in the forms, twelve inches of marsh hay was packed around them, and thermometers inserted against the form boards, which were read daily by the inspectors. It was found that even after seven days the thermometers registered as high as 70 degrees regardless of the outside temperature.

Scientific Methods Give Success

The excellent type of concrete obtained on this job is no doubt traceable directly to the scientific methods of control exercised by the engineers. The uniformity of the concrete is evidently partly due to the use of the inundator and the observations of water content by means of the slump test. The inundator has indeed worked out so well



The reinforcing bars are being placed exactly according to design and specifications, supported on the precast concrete units that may be seen at various points on the mat. The belt leading from the mixer that delivers the concrete to the buggies is to be seen on the left.

on this operation that the contractor has decided to use it on all subsequent concrete work, regardless of whether the work be done for the city or for private owners. With the type of specifications that are being enforced in this work by the city there is no direct saving to be gained by the contractor by its use, but on work where proportions are specified in the older manner, then the correct proportioning that the inundator permits will work to save materials for the contractor, and thus save money, without reducing the strength of the concrete being obtained. On this work, however, the contractor is enabled to deliver concrete even better than that specified without interfering in any way with his operations, and without extra cost to him. His better concrete is adding to his reputation as well as to the reputation of the engineers.

Some Hard Problems Solved

There were a few things about this job that called for the meeting of some rather difficult problems, and these problems brought out some methods of procedure that were interesting. On Wells street the street car track and an elevated structure had to be raised to new grade and yet kept in service at all times. This was done by excavating, putting the surface line tracks on timber bents above new grade, placing the new pavement at the desired grade, and then replacing the tracks. Temporary supports were also provided for the elevated structure. Traffic was not seriously interfered with at any time during this operation.

Because of the river-front location of the project, a lot of underground work had to be done under wet conditions. To meet this, extra wells were sunk and used as sumps for water pumped out of the wells being excavated and concreted. Special care was taken that the concrete was protected from water during placing. Pours were made continuously so that a great many construction joints were avoided. Great care had to be taken in this work not to penetrate existing freight subways. A great many other similar problems were met, and disposed of.

Setting a New Record

On the erection of the superstructure, a construction schedule was worked out that called for several extremely heavy days' work when concrete was to be poured. On August 10 a world's record for concrete poured in one day was said to have been established when 1,080 cubic yards of structural concrete were poured in a half block of slab during one day. The work started at six o'clock in the morning and did not stop until 1:30 the following morning. Two one-yard mixing plants were used, while a half-yard mixer was used to mix the special mortar that had to be placed in the bottom of the slabs and the beams. This mixer also prepared the granite finish for the sidewalks. The same crew of men were used throughout, except that the buggy men were replaced at four o'clock in the afternoon. About one hour's time was lost during the day by each mixer, when minor repairs had to be made.

On Friday, August 21, a still better record was made, when about the same quantity of concrete, poured under the same conditions, was poured in an hour's less time.

Sections 4 and 5a, now under construction, call for about 18,000 cubic yards of concrete, about 38,000 cubic yards of excavation, 1,037.5 tons of reinforcing steel, and a forest of form lumber. One interesting feature of these contracts is that there is approximately 200,000 square feet of form area on each section superstructure. There is required approximately 8 feet BM of lumber for each square foot of form area, which makes the total requirement for lumber for forms on each contract a total of 1,600,000 feet BM. Part of this lumber can only be used twice, while some can be used three times.

The work is proceeding under the supervision of the Board of Local Improvements, of which J. J. Sloan is president. The board is represented in the work by T. A. Evans, Chief Engineer, and A. Engh, Assistant Engineer. The activities of these engineers and their corps of assistants are aided by A. R. Lord, Consulting Engineer. The work is being executed under the personal supervision of the contractor, F. J. Hurlihy, president of the Mid-Continent Construction Company. W. K. Lyons, Jr., is engineer in charge of tests, representing the city.

Mr. Lord has expressed himself as not only highly pleased with the quality of the work done, but is highly gratified by the support given by the contractor and by the administration in making an unusually good job possible. Owner, engineer, and contractor all unite in striving to obtain the best sort of work that can be obtained, and are putting it across at a surprisingly low cost.

Minimum Requirements for Masonry Wall Construction

A 57-page report on recommended minimum requirements for masonry wall construction, recommended as suitable for the purpose of those revising or writing building codes, has recently been issued by the Department of Commerce. The report was prepared by a committee of architects and engineers organized by Secretary Hoover in 1921 to draft recommended uniform building laws for adoption by cities and states throughout the country. It consists of three parts:

The first, describing the committee's procedure in obtaining information bearing on this subject; preparing a report in tentative form and submitting it to those interested for criticism; and revising its recommendations after consideration of the constructive reviews thus obtained.

The second part presents a set of building code requirements for the regulation of masonry wall construction recommended for adoption or adaptation by those writing or revising building codes. These sections cover the quality of materials, maximum stresses for which masonry should be designed, matter of workmanship and the height and thickness of unstayed masonry walls both bearing and non-bearing. In general, the committee's investigations disclose that thinner walls than those usually required in building codes are safe except under abnormal conditions of loading, wind pressure or seismic disturbances.

Extensive tests of the fire resistance and crushing strength of various masonry materials and combinations were made at the Bureau of Standards and other places as a preliminary to the committee's report on this subject. Summaries of these investigations and much other valuable information on masonry wall construction not otherwise obtainable in concise form is given in Part III of the report. This part also is intended as an explanation of the code requirements advocated in Part II with the thought that their adaptation by code revision committees and their administration by building officials will thus be considerably facilitated.

Previous reports of the committee have received wide circulation and have been utilized in many cities and states. It is expected that the report on recommended minimum requirements for masonry wall construction will be welcomed by architects, engineers and builders. Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C.

The Design of Cement Concrete Pavements

Forces to Be Resisted by a Concrete Pavement

By A. T. GOLDBECK
Chief, Division of Tests, U. S. Bureau of Public Roads

(Concluded from CONCRETE, August, 1925)

Having considered some of the fundamental properties of concrete, we are now ready to study the forces to which a concrete pavement is subjected and to study the design of the pavement as it is influenced by these forces and by the properties inherent in the concrete itself.

We have stated that as soon as the moisture begins to

Table 3.—Frictional Resistance of Concrete on Various Subbases in Damp but Firm Condition

Kind of base	Movement Inches	Force Pounds	Coefficient	Movement Inches	Force Pounds	Coefficient	Movement Inches	Force Pounds	Coefficient
Level clay	0.001	480	0.55	0.01	1,130	1.3	0.05	1,800	2.07
Uneven clay	0.001	500	0.57	0.01	1,120	1.29	0.05	1,800	2.07
Loam	0.001	300	0.34	0.01	1,030	1.18	0.05	1,800	2.07
Level sand	0.001	600	0.69	0.01	1,080	1.24	0.05	1,200	1.38
¾-inch gravel	0.001	450	0.52	0.01	960	1.10	0.05	1,100	1.26
¾-inch broken stone	0.001	380	0.44	0.01	800	0.92	0.05	950	1.09
3-inch broken stone	0.001	1,060	1.84	0.01	1,550	1.78	0.05	1,900	2.18

Frictional Resistance of Concrete on Various Subbases in Thoroughly Saturated Condition with Water and Surrounding Ground Exceedingly Soft

Kind of base	Movement Inches	Force Pounds	Coefficient	Movement Inches	Force Pounds	Coefficient	Movement Inches	Force Pounds	Coefficient	Movement Inches	Force Pounds	Coefficient
Level clay	0.001	120	0.14	0.01	300	0.35	0.05	500	0.58	1.5	950	1.09
Uneven clay	0.001	200	0.23	0.01	460	0.53	0.05	620	0.71	1.4	925	1.06
Loam	0.001	150	0.17	0.01	260	0.3	0.05	410	0.47	0.75	925	1.06
Level sand	0.001	140	0.16	0.01	280	0.32	0.05	400	0.46	0.75	875	1.00
¾-inch gravel	0.001	510	0.58	0.01	640	0.73	0.05	950	1.01	0.5	1,050	1.2
¾-inch broken stone	0.001	400	0.46	0.01	660	0.76	0.05	940	1.08	2.0	1,160	1.33
3-inch broken stone	0.001	240	0.28	0.01	630	0.73	0.05	900	1.04	0.875	1,625	1.87
Oiled clay	0.001	150	0.17	0.01	410	0.47	0.05	850	0.98	1.25	1,425	1.64
Clay and cobble stones	0.001	140	0.16	0.01	410	0.47	0.05	710	0.82	1.75	1,260	1.45
Concrete base	0.001	2,500+	2.9 +	0.00	2,500+	2.9 +	0.00	2,500+	2.9 +	0.00	2,500+	2.9+
Sand, oiled	0.001	180	0.21	0.01	280	0.32	0.05	480	0.55	0.375	800	0.92
Concrete, oiled	0.000	2,500+	2.9 +	0.00	2,500+	2.9 +	0.00	2,500+	2.9 +	0.00	2,500+	2.9 +

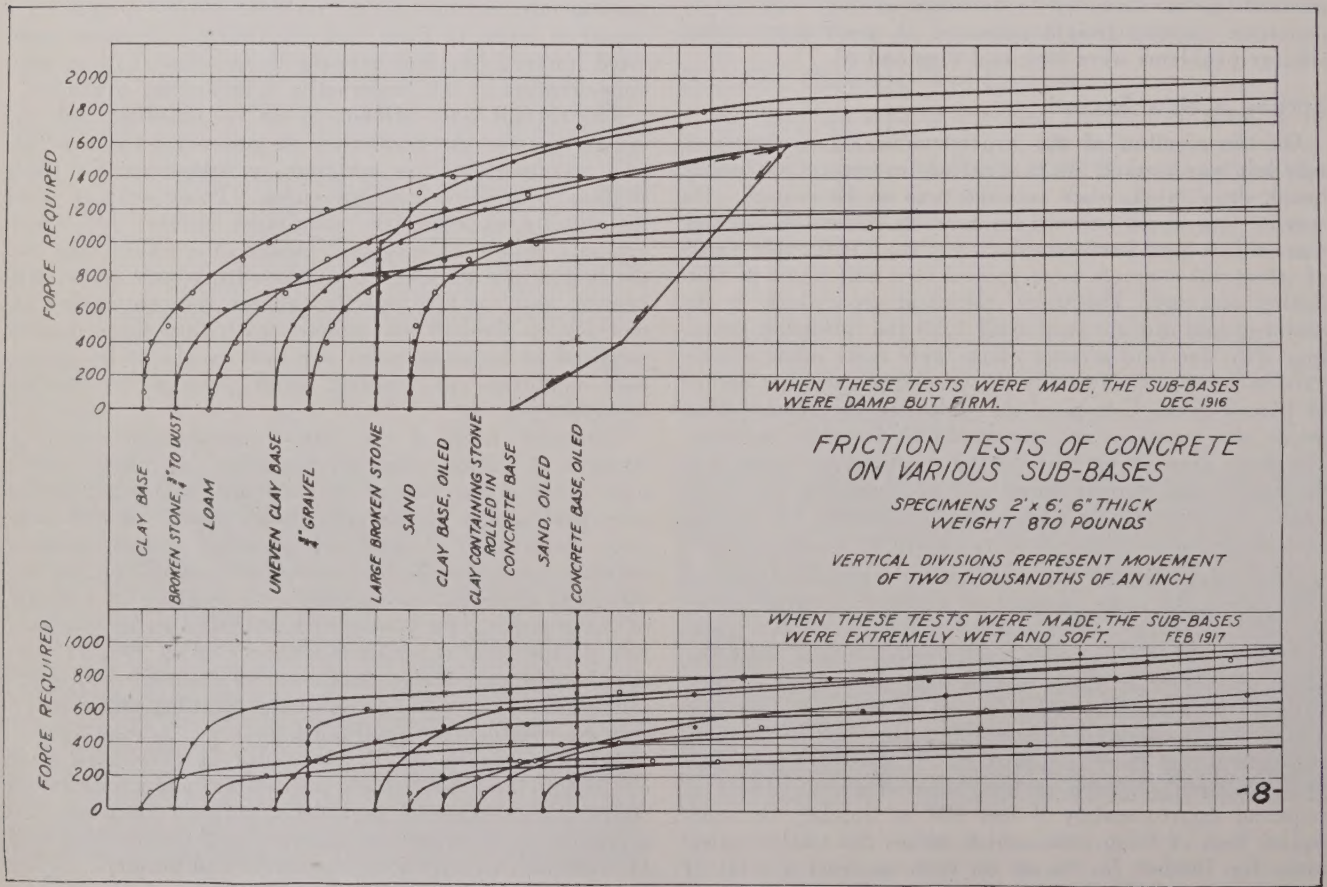


Fig. 8—Subgrade friction tests

dry out of the concrete it begins to shrink and therefore to move over the subgrade. Likewise we know that with a fall in temperature, contraction takes place, resulting in movement of the concrete over the subgrade. This movement is resisted by friction between the concrete and the subgrade. The magnitude of this friction was determined by the writer in the Bureau of Public Roads a number of years ago and its value is shown in Fig. 8.[5] The values for the coefficient of friction are shown in Table 3, the last column of which is most significant. It is seen that the friction might vary considerably, depending upon the character of the subgrade and also upon its degree of saturation. Roughly, it might be said that the coefficient of friction varies between 1.0 and 2.0. With a dry subgrade it is quite likely the value of 2.0 is not unusual and it can be higher.

Let us investigate the action of the forces of friction in producing transverse cracking in a concrete pavement. Suppose that the curing of the concrete is stopped after ten days and that shrinkage develops due to this cause and also to falling temperature.

Let f equal coefficient of friction = 2.0

Assume the tensile strength of the concrete S at this period, 10 days, equals 100 lb. per square inch. At the cross-section at which the tensile resistance of the concrete is just exceeded by the total force of friction a crack will take place. This is expressed algebraically in Fig. 9.

It is assumed in the calculations shown in Fig. 9 that the shrinkage or contraction does not begin until the end of ten days. Suppose, however, that there have been conditions of high shrinkage due to insufficient curing or too low temperature occurring at the end of 24 hours, at which time the tensile strength of the concrete might be only 40 to 50 lb. per square inch, or approximately one-half of that at ten days. This would lead to cracking transversely, with cracks approximately 20 to 24 ft. apart. The above calculations are necessarily not exact, for the assumptions are subject to a considerable range of value. They do show, however, that the behavior of the pavement will depend not only upon the design but also on the curing treatment that the pavement receives after being built. It is evidently important that curing be continued until high tensile strength is attained in order that the concrete might be kept expanded until it is ready to receive tensile stress. It is also important that the coefficient of friction between the subgrade and the pavement be reduced to a minimum, for this, too, influences the frequency of cracking. Careful preparation of the subgrade helps to reduce transverse cracking.

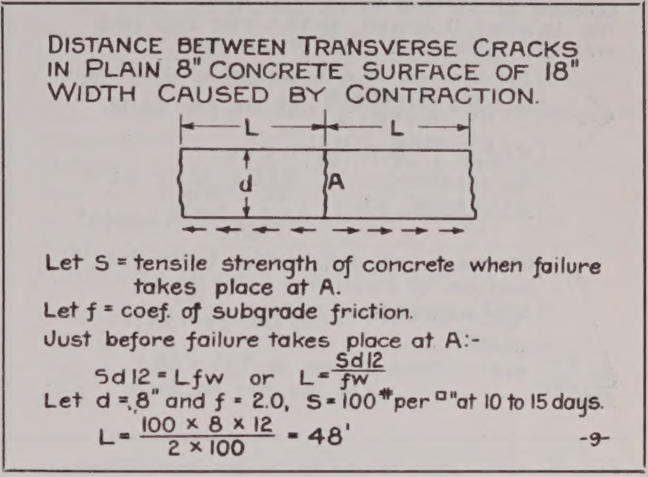
Allowance for Pavement Expansion

It has been pointed out that there are several influences which tend to change the length of a concrete pavement. They are:

(1) Temperature change
(2) Changes in moisture content

No doubt the pavement suffers from the combined influences of both of these agencies and in order to consider the necessity for the provision for expansion of a concrete pavement we must first consider the effects separately. Let us first neglect temperature. It has been indicated that when the pavement dries out it shrinks because of moisture evaporation under extreme conditions as much as .0005 in. per inch of length, a distance of .6 in. per 100 ft. Perhaps under more normal conditions because of the moisture accumulated from the subgrade the shrinkage factor is less than the above amount. So far as our tests have shown it is doubtful if the concrete ever regains this shrinkage even in times of wet weather although it may very closely approach its original length due to moisture in the spring of the year.

Other experimenters, however, seem to believe that the concrete might actually grow in length due to the saturated condition. The expansion of concrete as we have measured it seems to amount to .0001 in. per inch of length, the equivalent of a little more than .1 in. per 100 ft., a negligible amount. So far as temperature is concerned, much depends upon the time of the year when the concrete is laid as to whether or not much allowance need be made for expansion. If the concrete is laid in cold weather, say, 50° F., there is the possibility of a temperature increase of perhaps 70°, with a change in length of approximately ½ in. per 100 ft. If to this be added the moisture expansion in the spring of the year a total expansion of .6 in. per 100 ft. will take place. If it seems desirable to eliminate direct compression in concrete from this cause it would seem necessary to provide for expansion of at least this amount, and necessarily if the joint filling material is to remain effective as a moisture excluding agent during times of shrinkage, the expansion joint would theoretically have to be wider than .6 in. If the concrete, however, were laid in warmer weather, the allowance for expansion could be reduced. There is some question, of course, as to the economy resulting from the use of expansion joints. If no provision is made for expansion, the compressive stress produced in the concrete by an expansion of .6 in. per 100 ft. is approximately 2000 lb. per square inch, and were it not for the fact that the concrete probably behaves in a somewhat plastic manner and thereby relieves this stress, more failures by blow-ups would occur than at present.



DISTANCE BETWEEN TRANSVERSE CRACKS IN PLAIN 8" CONCRETE SURFACE OF 18" WIDTH CAUSED BY CONTRACTION.

Let S = tensile strength of concrete when failure takes place at A.

Let f = coef. of subgrade friction.

Just before failure takes place at A:-

$$Sd12 = Lfw \quad \text{or} \quad L = \frac{Sd12}{fw}$$

Let d = 8" and f = 2.0, S = 100# per □" at 10 to 15 days.

$$L = \frac{100 \times 8 \times 12}{2 \times 100} = 48'$$

-9-

Fig. 9—Transverse crack spacing

This much seems certain, unless provision is made for movement of the concrete, rather high direct stresses are apt to be produced in times of combined wet weather and high temperature. This fact is well illustrated by the many blow-ups occurring in the spring of the year. The neutralizing effect of drying out of moisture is also well illustrated by the fact that many blow-ups recede during the progress of the summer owing to the drying out of moisture from the pavement.

Warping of the Concrete

Since concrete changes in length both due to temperature and moisture, it becomes quite apparent that if either of these effects is prevalent more on the top of the slab than on the bottom there will be greater change in length of the slab at the top than at the bottom and consequently it must warp. At night, the slab generally cools more on the surface than at the bottom. The top surface therefore contracts, and for this reason it is often the case that the edges of the slab and the corners are curled up away from the subgrade. During the day the reverse is true; the top surface is heated and the bottom surface remains more or less at a constant temperature and the slab bears heavily on the subgrade at the sides and corners. These facts are not based merely on theory, but they have been demonstrated a number of times in the Pittsburgh Test, the Bates Test, at Arlington and elsewhere. It is readily apparent that warping of the slab might have considerable effect on the pavement, for when it is warped away from the subgrade heavy passing vehicles bend it back into contact with the subgrade and in so doing cause high stresses. In Fig. 10 are shown calculations illustrating the high stresses which might result from traffic which bends the corner of a slab back into contact with the subgrade after it has been warped due to temperature. Although the conditions of support for the slab may have been assumed in a somewhat severe manner, nevertheless the possibilities for high stress are evident.

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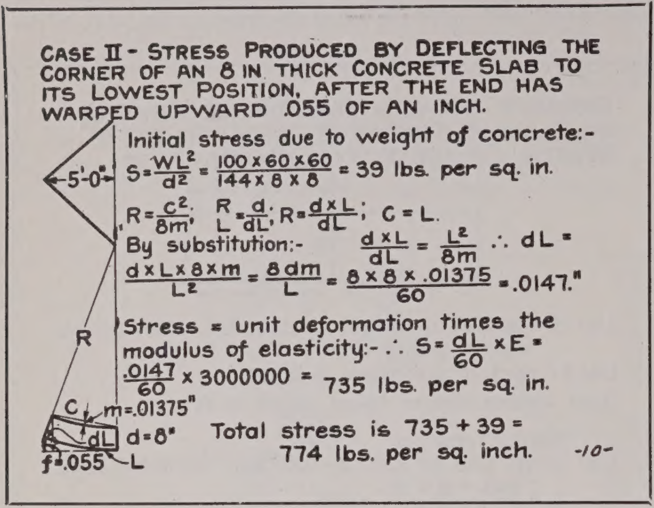
[5] *Public Roads,* Vol. 5, No. 5, "Friction Tests of Concrete on Various Subbases," by A. T. Goldbeck.



CASE II - STRESS PRODUCED BY DEFLECTING THE CORNER OF AN 8 IN. THICK CONCRETE SLAB TO ITS LOWEST POSITION, AFTER THE END HAS WARPED UPWARD .055 OF AN INCH.

Initial stress due to weight of concrete:-

$S = \frac{WL^2}{d^2} = \frac{100 \times 60 \times 60}{144 \times 8 \times 8} = 39$ lbs. per sq. in.

$R = \frac{C^2}{8m}$; $\frac{R}{L} = \frac{d}{dL}$; $R = \frac{d \times L}{dL}$; $C = L$.

By substitution:- $\frac{d \times L}{dL} = \frac{L^2}{8m}$ $\therefore dL =$

$\frac{d \times L \times 8 \times m}{L^2} = \frac{8dm}{L} = \frac{8 \times 8 \times .01375}{60} = .0147''$

Stress = unit deformation times the modulus of elasticity:- $\therefore S = \frac{dL}{60} \times E =$

$\frac{.0147}{60} \times 3000000 = 735$ lbs. per sq. in.

Total stress is $735 + 39 =$ 774 lbs. per sq. inch.

Fig. 10—Stress produced at a corner by traffic and warping

Effect of Wheel Loads

In studying the effect of wheel loads on pavements it is pertinent to inquire as to just what wheel loads are to be expected on concrete pavements, and, moreover, how those wheel loads are distributed on the pavement.

Traffic Census Studies

A number of studies have been made by various states, many of them in co-operation with the Bureau of Public Roads, in order to determine the distribution of traffic over state highway systems.

In taking these traffic censuses information was obtained as to the point of origin and destination of the vehicles and each vehicle was likewise weighed in order to determine wheel load distribution. In all the studies thus far made there were certain outstanding facts developed which are significant from the standpoint of concrete highway design. Perhaps the most significant is that on only a very small percentage of the highways are to be found the extremely heavy trucks and these are relatively few in number. In general the very heaviest trucks do not travel very far away from the large centers of population or they are found to be confined to certain routes which they travel because of the location of a certain industry such as a crushing plant or coal mine. Certain principal routes are apt to have comparatively heavy trucks on them, although not the heaviest, while other secondary routes may never receive vehicles in excess of two or three tons capacity. Apparently the distribution of heavy motor vehicle truck travel is somewhat automatically governed by the economy with which such vehicles can be operated, and no doubt by other considerations.

The main point, however, is that all pavements need not be designed for the heaviest loads which exist in the state, but due recognition should be taken of distribution of traffic as discovered by a properly taken traffic census, making sufficient allowance for increased weight of traffic in the future. When considering the design of a concrete pavement, however, it is perhaps unwise to make the pavement any thinner than that requisite for carrying a truck of 3-tons capacity.

In Table 4 are shown the wheel loads on two different routes in Pennsylvania.

TABLE NO. 4—TRAFFIC CENSUS DATA FROM A HEAVY AND A MEDIUM TRAFFIC LOAD

Route No. 142—Philadelphia to Ardmore, Pa., daily truck traffic 600 trucks

Loads	Percentage	Maximum Wheel Loads
18,000 and under	90.5	5,500
18,000-24,000	6.4	8,500
Over 24,000	2.1	13,500

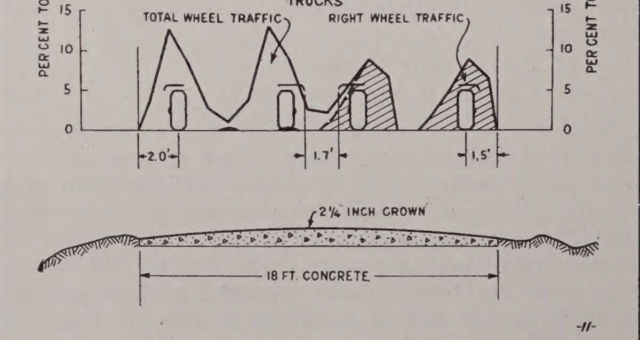
Route No. 84—Erie to Meadville, Pa., daily truck traffic 125 trucks

Loads	Percentage	Maximum Wheel Loads
18,000 and under	98.1	5,500
18,000-24,000	1.9	8,500

If these figures alone are to be used for the load assumptions for design purposes it is obvious that route No. 142 would require a heavier road than route No. 84. The best prediction possible, on the basis of the present traffic census, the industrial conditions in the surrounding territory, the growth of population and other pertinent factors, should be made to determine the maximum wheel load to be used for calculating the cross-section design.

Distribution of Traffic Over Width of Pavement

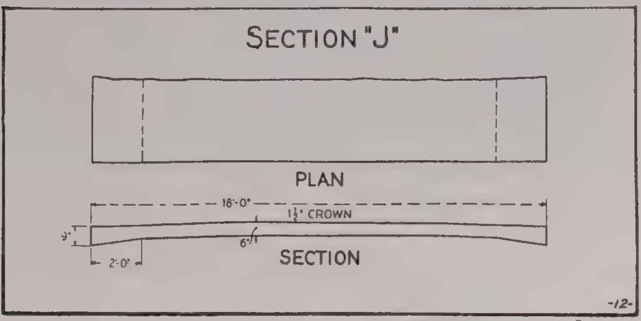
Before considering the effect of the traffic on a concrete



TEST NO. 4 - TRANSVERSE DISTRIBUTION CURVES OF MOTOR VEHICLE TRAFFIC ON 18 FOOT CONCRETE PAVEMENT. SHOULDERS, IN FAIR CONDITION AND GRADE-LEVEL. DISTRIBUTION IS UNIFORM. AVERAGE SPEED 12 TO 25 MILES PER HOUR FOR TRUCKS AND PASSENGER VEHICLES RESPECTIVELY

Fig. 11—Traffic distribution over width of pavement

pavement it will be well to inquire into the position on the pavement which the traffic ordinarily assumes. Studies have just been completed by the Bureau of Public Roads which throw considerable light on this question. The studies consisted merely of counting the vehicles which passed over given marks painted on the pavement. In Fig. 11 a curve is shown which is somewhat typical of an 18-ft. concrete pavement. The traffic will be distributed differently of course, depending upon its intensity, upon the width of the shoulders, the presence of vertical and horizontal curves and other influences. In general, however, the traffic is apt to run anywhere on the pavement, although the most frequent wheel load passage is at the center.



U. S. BUREAU OF PUBLIC ROADS 28784

Fig. 12—Thickened edge design of the Pittsburg Road Tests

Where there is no center longitudinal joint it is seen that the truck traffic is concentrated approximately 18 in. to 2 ft. away from the edge of the pavement with the high intensity of traffic, due to the passage of wheels in opposite direction, at the center of the pavement. A center longitudinal joint does not seem to help this condition very much so that, in general, it might be said that a large number of trucks will trail along a line 18 in. from the edge of the pavement; some of them will run out at the extreme edge and a very large number of the wheel loads will be applied near the center of the pavement. Since the heavy vehicles are found to run everywhere on the pavement, it is important that the design be such that the pavement will not be over-stressed no matter what the position of the wheel load.

Investigation on Design

There have been three major investigations, all of which throw light on the load-carrying capacity of different cross-section designs. They are the Pittsburg Test Road in California, the Bates Test Road in Illinois and the Arlington Experiments of the Bureau of Public Roads. The cross-section which all of these experiments point to as the strongest for supporting heavy loads everywhere is that having a thickened edge.

In Fig. 12 is shown the cross-section which has given the highest rating as a result of the Pittsburg Test Road. This cross-section was originally developed by the California Highway Commission, but was not used to any great extent. As a result of the Bates Road Test, in which a number of different cross-sections of pavement were subjected to gradually increasing loading, a design similar to the California design was finally selected as being of the highest all-round strength for a given amount of concrete. The tests made at Arlington were not tests to destruction, as in the case of the Bates and Pittsburg roads, but by means of stress measurements the maximum deformations in different thicknesses of pavement were obtained under the action of heavy vehicles. These vehicles were purposely run in different positions on the slab with the wheels tracing along the outer edge and along lines at different distances from that edge. As a result of these measurements it has been possible to plot maximum stresses occurring in slabs of uniform thickness and a typical set of such deformations is shown in Fig. 13. These readings are very illuminating, for they show very much higher stresses along the edge of the slab than at the center, thus bearing out the conclusions reached from the Pittsburg and Bates Road Tests, that it is well to strengthen the edge of the slab in order that it might be sufficiently resistant to heavy loads. It is interesting to note from these curves that the very highest tension occurs at the edge of the slab at the bottom, very likely directly under a heavy wheel load. There can also be high tension at the top of the slab at the edge, occurring in all probability several feet away from the heavy wheel loads.

High tension can also exist at a corner at the top of the slab. More recent readings of a similar character taken on a pavement of the Illinois cross-section, whose center thickness was approximately .7 of the edge thickness, show stresses at the center not greatly different from those at the edge, thus indicating that when a center longitudinal joint is used, the center thickness should be approximately .7 of the edge thickness.

Formulas for Designs of Cross-Section

In the Bates Road Test the traffic was purposely run with the rear wheels trailing along the edge of the slab and a large number of corner breaks occurred. Naturally

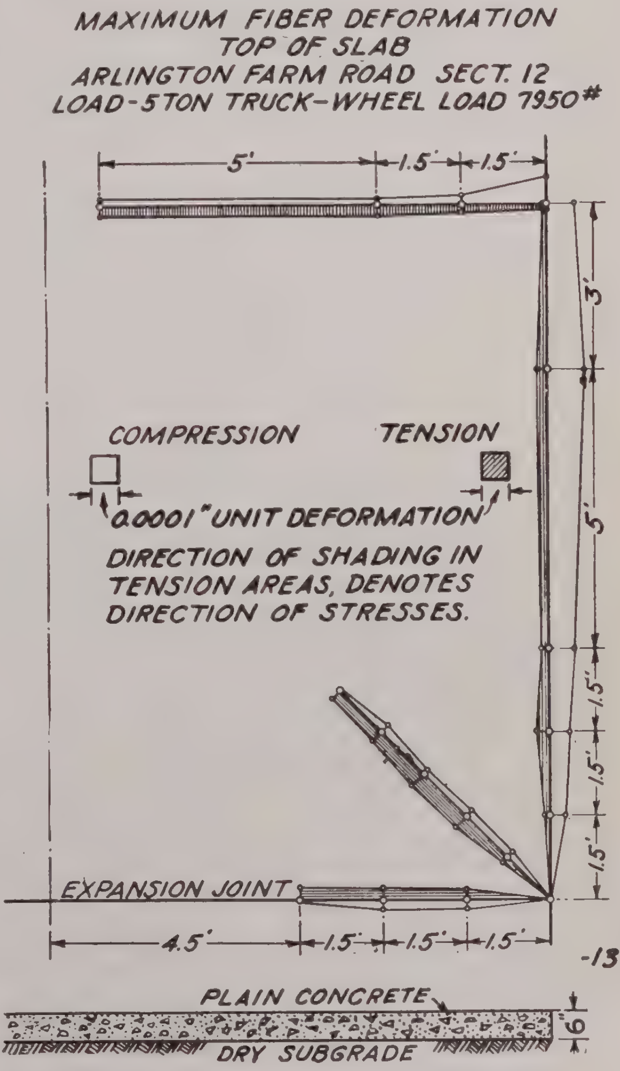

MAXIMUM FIBER DEFORMATION
TOP OF SLAB
ARLINGTON FARM ROAD SECT. 12
LOAD-5 TON TRUCK-WHEEL LOAD 7950#
5'
1.5'
1.5'
3'
5'
1.5'
1.5'
1.5'
COMPRESSION
TENSION
0.0001" UNIT DEFORMATION
DIRECTION OF SHADING IN TENSION AREAS, DENOTES DIRECTION OF STRESSES.
EXPANSION JOINT
4.5'
1.5'
1.5'
1.5'
-13-
PLAIN CONCRETE
6"
DRY SUBGRADE

Fig. 13—Maximum deformation in top of concrete pavement under traffic

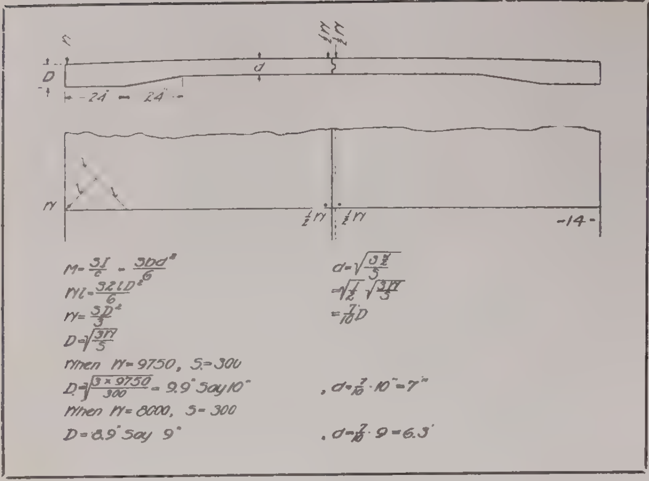


Fig. 14—Calculation of slab thickness by corner theory

the thicker the slab at the edge the greater was the wheel load which that slab was capable of carrying. The details of this investigation have already been published. The principal conclusion arrived at, however, is that for the subgrade conditions existing at the Bates Road and common to Illinois it is now possible to predict the load which will cause failure of the slab at the corner. This is accomplished merely by considering the corners formed by transverse joints or transverse cracks as unsupported cantilever beams of uniform strength and using the flexure formula for this condition. The prevention of corner cracking is considered important because when a small area of concrete is formed thereby, rapid and progressive failure results. Laboratory tests on concrete have shown that for dry concrete it is possible to apply repeated stress almost indefinitely up to slightly more than 50 per cent of the modulus of rupture without causing failure. Whereas, if the stress in the concrete exceeds approximately 50 to 55 per cent of the modulus of rupture, failure is apt to take place after a comparatively few load applications. This suggests immediately that it is safe to design the corners of a concrete pavement on the basis of a cantilever beam of uniform strength, the load being applied at the extreme corner and the unit stress not exceeding 50 per cent of the modulus of rupture.

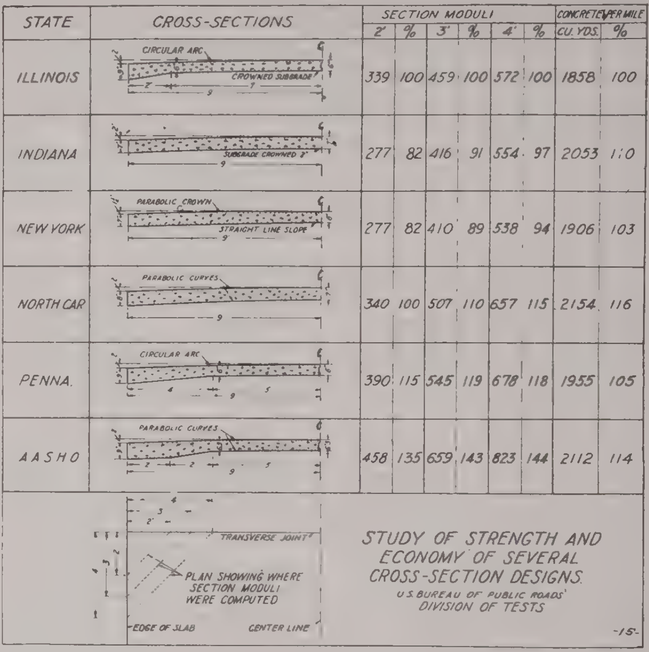
In Fig. 14 there is shown an analysis for these assumed conditions. Where a center longitudinal joint is used with a tongue-and-groove joint or with efficient dowel construction for transferring load across the joint, it can be considered that two corners are supporting a single wheel load with the result shown in Fig. 14, the center thickness equaling 7/10 of the edge thickness. Examples of the application of this formula to given load conditions are also illustrated in Fig. 14.

It is to be acknowledged that the above formulas are only approximate, for they neglect a number of factors which are known to be present. A short discussion of these factors might be given as follows:

(a) The formula neglects any support of the load from the subgrade. Undoubtedly there are times when the corners of the slab are, for practical purposes, unsupported. On the other hand it is also probably true that a large percentage of the time the subgrade does offer material support. For the worst conditions the assumption of an unsupported cantilever is probably not too severe.

(b) Stress measurements indicate that higher tension is to be expected longitudinally along the edge of the slab than at the corner. Therefore, the initial crack is apt to occur first as a transverse crack starting at the edge of the slab. Therefore when the pavement is designed on the basis of the corner formula a higher tensile stress is apt to be produced along the edge of the slab than would be indicated by the corner formula which is concerned with the diagonal stress at the corner.

(c) The formula assumes that the load is applied statically. This neglects the fact that conditions are very often not ideal with regard to either smoothness or to conditions of truck tires. Impact does exist, especially with fast moving vehicles equipped with solid tires. The effect of this impact probably is offset to some extent by the assumption of no subgrade support and also by the severe assumption that the load is applied at the extreme corner. As shown by actual traffic surveys, a very large percentage of the vehicles never run with their wheels at the extreme corners.


CIRCULAR ARC
CROWNED SUBGRADE
SUBGRADE CROWNED 2"
PARABOLIC CROWN
STRAIGHT LINE SLOPE
PARABOLIC CURVES
CIRCULAR ARC
PARABOLIC CURVES
TRANSVERSE JOINT
PLAN SHOWING WHERE SECTION MODULI WERE COMPUTED
EDGE OF SLAB
CENTER LINE
-15-

STATE	CROSS-SECTIONS	SECTION MODULI						CONCRETE PER MILE	
		2'	%	3'	%	4'	%	CU. YDS.	%
ILLINOIS		339	100	459	100	572	100	1858	100
INDIANA		277	82	416	91	554	97	2053	110
NEW YORK		277	82	410	89	538	94	1906	103
NORTH CAR		340	100	507	110	657	115	2154	116
PENNA.		390	115	545	119	678	118	1955	105
AASHO		458	135	659	143	823	144	2112	114

STUDY OF STRENGTH AND ECONOMY OF SEVERAL CROSS-SECTION DESIGNS.
U.S. BUREAU OF PUBLIC ROADS' DIVISION OF TESTS

Fig. 15—Study of section modulus at corner of slab

(d) The results of tests on fatigue of concrete show that concrete is safe against failure if the unit stress does not exceed 50 per cent of the modulus of rupture. This applies to dry concrete. When the concrete is saturated, however, failure takes place much more quickly. It has been stated, for instance, that whereas 300,000 applications of stress, equivalent to 53 per cent of the modulus of rupture, were applied to dry concrete, only 3000 to 8000 applications of a similar stress were necessary on wet concrete to produce failure.

(e) In calculating the corner as a beam of uniform strength, it is assumed that the thickness is constant across the width of the cross-section at each corner. In order that this assumption might hold true, it will be necessary to have a constant edge thickness over several feet, measured from the edge of the slab. Actually such a cross-section is practically never used.

The net effect of the above points as above discussed is that the corner formula as now used probably would not be safe against corner cracking were it not for the fact that very seldom do the loads travel over the extreme corner but actually they travel, for the most part, at least a foot or more from the corner. The corner theory for the design of the slab, although not final, is the most acceptable theory we have at present and seems to be giving satisfactory results.

(To be concluded next month)

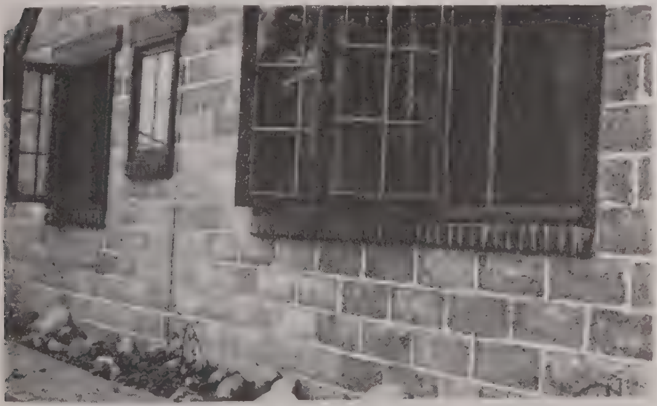
Here is the modern home that was built with cinder block walls, cinder concrete floors, Celotex lining, and a composition shingle roof.

The large apartment building in Riverside, built of cinder block covered with a face brick veneer.

Cinder Concrete Blocks in Residence Construction

How Builders Are Erecting Fireproof Structures at Hardly More Than the Cost of Frame

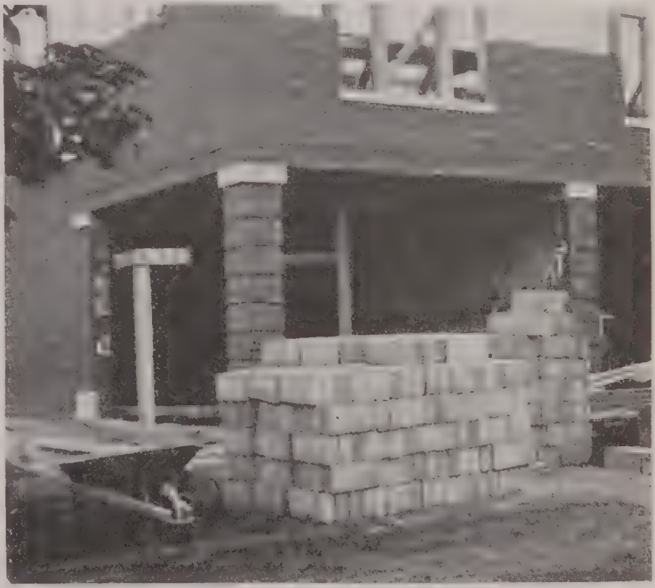
In the heart of the brick country, where common brick enjoys a real market and where "substitutes" find hard sledding, cinder block are now being used on bearing walls of smaller structures and are frequently being used for backing up face brick and other finishes in place of the usual common brick. It's a matter of dollars and cents to the builder, for cinder block, laid in the wall, costs somewhat less than does the ordinary brick that is usually insisted upon.



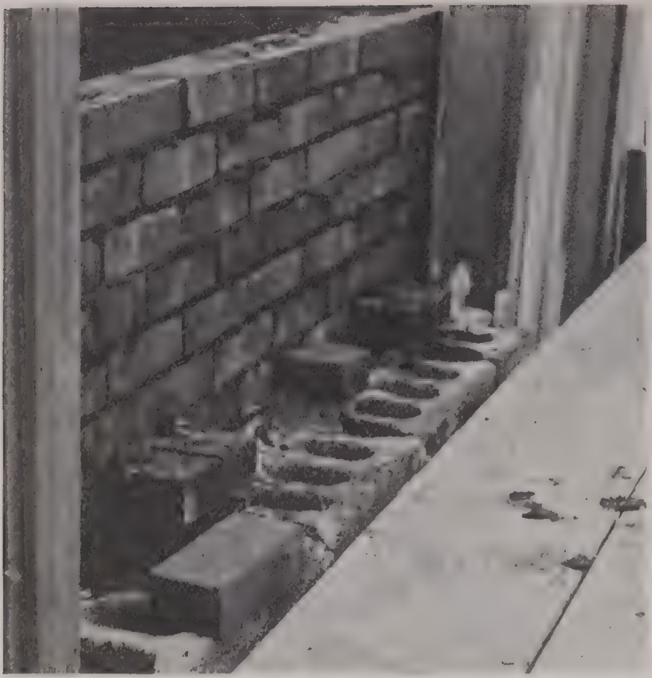
A closeup showing window treatment in the cinder concrete home. The blocks are being left uncovered to obtain the desired architectural treatment and for the sake of economy.

Take the 43 apartment building now under erection in Riverside, Ill., for instance. Here, H. K. Meincke & Brother are spending some $250,000 on a court building of the latest type, and are building it for their own investment and not for sale to someone else. Last year they erected a building of this type and used cinder block in the bearing walls and main partitions. They were so pleased, that the same construction is being used in the duplicate of the first building which is now under construction on the adjoining lot.

On the main bearing walls of this structure the ordinary eight-inch block, manufactured by the Illinois Cinder Block Corporation, Forest Park, Illinois, is being used. On the exterior the block are used to back up the face brick, and are bonded with the brick by means of headers every two or three courses. Even on exterior walls the cinder block are saving the builder quite a bit of money. These walls are carried up in the usual manner, with girders and joists framed into chases, and plastering is done directly onto the block. This makes it easy to obtain a really true and smooth plastered surface with a saving of a great deal of material. With lath, the plaster must run between the laths to form keys, and this requires a great deal of plaster, as every builder well knows but with cinder block the plaster keys itself into the minute cavities



This two-story store and flat building has all bearing walls of cinder block with front and one side covered with a face brick veneer. Plaster is put directly on the cinder block.



When bonding the face brick to the cinder block wall, headers are used as in this illustration, and stretchers fill the space left in wall at the binder course.

on the surface of the block, giving a uniform series of small keys that hold the plaster securely in place without taking any more material than is needed to actually give the required thickness of plaster. Cracking cannot occur unless the block itself cracks, and a perfectly rigid construction is obtained.

On the series of garages that are being erected for the convenience of the tenants, a four-inch partition block is being used. This is a three-cell unit that weighs but little more than does the ordinary gypsum partition tile. It lays up well, and takes plaster without difficulty. Conduits and other items are easily nailed directly to the partition just as is possible with the familiar eight-inch cinder concrete block.

When it comes to laying up the wall the contractor has found that the cinder block affords real economies. On straight wall work the average good mason can easily lay 400 of these blocks in a day. Now this quantity is usually considered as the equivalent of 5,000 brick, and it is rather unusual to find a bricklayer today who will reach the two thousand mark on ordinary brick walls. In fact, the usual experience of today is that the average performance is somewhat below the two thousand mark. When costs are compared, on the basis of $1.50 per hour for bricklayers, it will be found that laying 400 cinder blocks in the wall will cost no more than laying about 1,500 to 2,000 brick, or less than half the cost of laying brick. The price of brick may be taken for the purpose of comparison, as $12.00 a thousand, or $60.00 worth to fill the wall space occupied by 400 block. Block may be quoted at .20 each or $80 for 400. The labor of the bricklayer alone for laying 5,000 brick will total about $40.00 on this basis. To recapitulate:

Brick		Cinder Block	
5,000	$60.00	400	$80.00
Labor	40.00	Labor	12.00
Total	$100.00	Total	$92.00

This comparison does not take into account the time of a helper, or 1½ helpers (depending upon job conditions) nor of the mortar needed. If these items were considered in the comparative costs, as would be the case in figuring actual work, the saving made by the use of cinder block would be still greater.

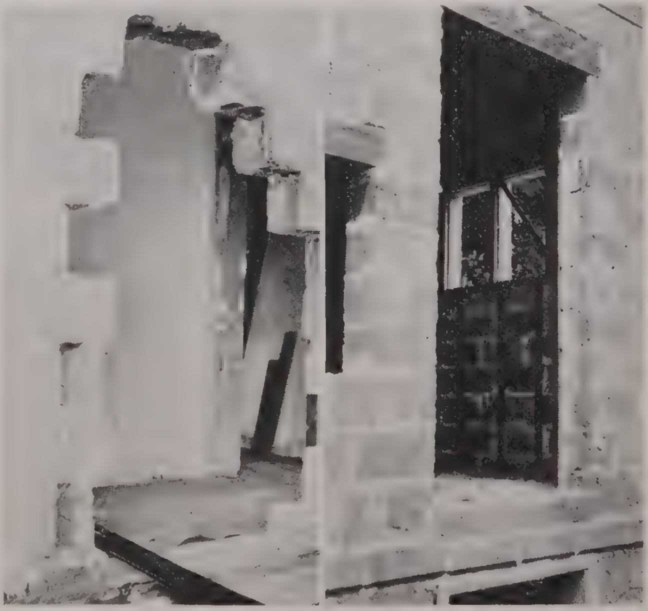
The fact of the matter is that it costs this contractor about 12 cents each to lay the cinder block, including labor and mortar, but not including the cost of the block, which adds another twenty cents to the cost.

Not only is he getting a strong, fireproof wall at a low cost, but he is able to further reduce his costs by eliminating the use of nailing strips and blocks, due to the "nailability" of the cinder block, is saving plaster, is eliminating the necessity for furring and lath on inside walls, and is saving plaster on the inner walls. In addition he will find his coal bill lower when the building is in use, and will save on decorating because of the permanent nature of the plaster on the inner walls.

There are a great many other buildings being erected in the suburbs of Chicago using cinder block and other cinder concrete products in their construction. Basement walls of cinder block, bearing walls of cinder block left bare or covered with stucco or brick veneer, and chimneys of cinder chimney block; all these things are to be seen on every hand.

The writer visited a great many residences that were built of cinder block, and took occasion to notice the freedom from cracks on the plaster and stucco walls, the dryness of the basements when properly constructed, and the general appearance of solidity shown in every structure. Residents of these buildings expressed themselves as quite satisfied with the livable qualities of their homes and the ease with which the buildings could be heated.

One home in Lombard, Ill., that was visited, was of especial interest. This one, built in a large measure by the owners themselves, not only had exterior walls of cinder block, but had a cinder concrete floor as well. This building, owned by Mrs. Kuttner and Mrs. McFarquher, was found to be a single story dwelling without a basement. The heating plant, of the most modern type, was located in a special room off the kitchen. The cinder block walls were left uncovered, presenting a rather pleasing appearance, while the inner side of the wall was



Right: The detail of door and window framing as ordinarily specified, together with furring strips in place on inner side of exterior wall ready for lath. Left: This is how plaster is put directly on each side of a dividing wall of eight-inch cinder block. Notice that no lath is called for. This type of construction may also be used on exterior walls.

finished with Celotex nailed directly to the block. A cinder concrete floor, about six inches thick and bedded on a layer of cinders, was provided for the whole house. This floor, which was a two-course floor with a troweled finish, was painted with two coats of a cement paint, and had somewhat the appearance of linoleum. Wood chair rail and other wood trim were eliminated, while window sills were of magnesite composition cast on the job. The owners were very enthusiastic about the practicability of this type of a structure and stated that it cost far less than would other types of fireproof homes. They claimed that the house could probably be duplicated for $5,000 including oil burning heating plant, water softener, and all other modern conveniences.

There is practically nothing new to be observed in the actual method of construction where cinder block is used. In straight wall work the block are laid up in the usual way, framing openings by means of half block or jamb block. Brick veneer facing is tied to the cinder block wall by means of headers and filling is done with stretchers on the inner surface when four-inch cinder block is not available for the purpose. When using built-up roofing on a flat roof, the roll roofing is carried up over the top of the wall and nailed to the cinder block. When this is covered with the tile coping a watertight roof results without the use of flashing. On interior work, when electric conduits, and other service items are to be installed on a wall or partition, they are nailed directly to the cinder block without inserting nail holes. Meter panels and switch panels are secured directly to the wall in the same way, while breaches are easily made for running pipes through any partition. Trim is simply nailed into place on the masonry.

Two coat plaster work is easily done on the cinder block wall. The first coat flows on evenly and clings to the block with minimum use of material. The finish coat is then easily applied to proper grounds in the usual manner. Plasterers are said to like this sort of a base as their work is done rapidly and without much trouble. The tile seems to have just the right amount of suction to take the plaster without giving it too dry a set, and there is no bother with getting keys between lath as there is in ordinary construction

Most of the cinder block used in the suburban towns west of Cicago is made under the Straub patents at the plant of the Illinois Cinder Block Corporation. The plant, which has a capacity of about 1,200 block a day, operates two machines. The cinders are brought in by rail at the rear of the plant and are stored in piles in the yard. The mixer hopper is fed from stock pile by hand, and the cement, which is purchased in sacks, is put into the mixer from the side just in front of the cinder hopper. The mixer is of the continuous type, and delivers material at the right speed to keep both machines busy. The concrete is dumped from the mixer onto the floor, from where it is loaded into each machine by hand.

The machines are located to the right and to the left of the discharge of the mixer. A Hobbs face-down machine takes care of the block that are to be given a facing of ordinary concrete, while an Anchor Stripper turns out the regular cinder block. The Hobbs machine is also equipped to form the four-inch block and some specials manufactured by the company. From the machine the block are loaded onto the usual cars and placed in the kiln, where they remain for the required period. The cured block are then taken to the yard and stacked until required by the contractors. From start to finish all the work moves in one direction, and the plant is easily operated with from seven to ten men. The mixer requires one man, two men are needed on each machine, one man is needed for offbearing, and the rest of the crew is used in the yard.

This manufacturer keeps a good stock of all standard items in the yard and is able to give immediate delivery on any normal quantity of block. On the larger work, deliveries are easily arranged to meet current requirements. The yard operates on a base price at the yard, plus a fixed scale of prices for delivery. All block manufactured must come up to pretty stiff requirements, and constant tests are made to see that the quality is kept up to standard.

Large Construction Program for Spain

According to a cable received from Commercial Attache Charles H. Cunningham, Madrid, a decree was issued under date of August 4, creating an organization for the administration of the 2,600,000,000 pesetas railroad debt for effecting an ambitious railroad construction program. An amortizable state debt for flotation within five years was created by Royal decree on July 25. Under date of July 29, the Government authorized an additional 100,000,000 pesetas for the construction of inexpensive dwellings costing a maximum of 60,000 pesetas, with the object of providing employment and relieving the housing shortage experienced by the middle classes.

It is planned to erect a large exhibition hall in Glasgow to replace Kelvin Hall, which was destroyed by fire on July 7, 1925, Consul G. C. Chamberlain, Glasgow, advises the Department of Commerce. Estimates given by the local press for the erection of this structure range from £250,000 to £1,000,000,000 and the hope is expressed that the new building will be under construction late this year or early in 1926. Tentative plans for the new building provide for all modern safety appliances such as automatic sprinklers, etc. Plans and specifications will be issued by the Glasgow Corporation, City of Glasgow, Scotland.

New Hospital Contemplated for Canadian City

The council of a Canadian city has finally fixed upon a site for its new hospital, Consul N. F. Brand, Fernie, B. C., advises the Department of Commerce. The building will consist of three floors; namely, ground floor, first floor and second floor. The ventilation will be by forced washed air, conducted to each room in the building. Provision will also be made for a laundry having mechanical washers, drying machine, ironers, etc. The building will be of red pressed brick, relieved externally by white cement pilasters and cornice, will be practically fireproof, and will accommodate between 50 and 60 patients.

Highway in Chile to Be Widened

In February, 1925, a decree was enacted providing for the widening of the highway connecting Santiago with San Bernardo, one of the suburbs, Commercial Attache R. H. Ackerman, Santiago, informs the Department of Commerce. For this work, the President of the Republic was authorized to issue Treasury bonds to the sum of 8,150,000 paper pesos at 8%.

The Minister of Public Works has now instructed his department to prepare necessary plans for the execution of this work and has requested the Treasury Department to issue 1,000,000 paper pesos of 8% bonds for expropriating necessary properties. The work will be let to those contractors offering most favorable bids.

Portland Cement Association to Build Own Home

Contracts have just been let by the Portland Cement Association to the Turner Construction Company of New York for a five-story office and laboratory building at the southeast corner of Grand Avenue and Dearborn Street, Chicago, Ill. This reinforced concrete structure is to be the general headquarters and home of the Portland Cement Association, which for the past 10 years has had its general offices on the fifteenth floor of the Conway Bldg. During the same period the association's research laboratory, which is known from one end of the country to the other as the Structural Materials Research Laboratory, has been located in the Lewis Institute, Madison and Robey Streets, where it has been conducted co-operatively by the association and the institute. The laboratory work has grown rapidly in importance for several years past, not only to engineers and architects but to individual users of cement. As a matter of fact, the dissemination of the findings of research work, which has made the association recognized as one of the greatest service organizations in the country has called for a continual increase in the general staff which has required continual expansion of office and laboratory quarters. Having all of its headquarters' facilities grouped in its own structure, the association will be better than ever prepared to make available to everyone its facilities directed toward improving and extending the uses of concrete.

The Turner Construction Company has for many years been recognized as a specialist in the erection of reinforced concrete mercantile, office and industrial buildings throughout the eastern half of the United States. Holabird & Roche, well known Chicago architects, planned the association's new home.

Foundations for the association building will be such as to permit the erection of additional stories of increased demands on the association for service to cement users call for more office or laboratory space.

The architects, co-operating with the building committee of the association and its engineers, have planned a building which is distinctive primarily because substantial, firesafe and expressing the economies capable with reinforced concrete design, as well as the architectural possibilities of concrete from the standpoint of art in architecture.

This is the new building to be erected by the Portland Cement Association to house its offices and laboratories. Modern construction methods will be used in its erection, and all kinds of concrete work applicable to such structures will be employed

Precast concrete stone similar to that used in the Grant Park Stadium on the lake front will be used for the Grand Avenue and Dearborn Street elevations. Monolithic concrete walls will be used on the other sides. On the interior there will be free use of cast concrete stone. The decorative wainscoting of the entrance vestibule, reception room, elevator lobby and conference rooms will be of cast stone or art marble consisting of portland cement and selected marble chips as aggregates. In various places throughout the building the plaster and cast concrete products used will demonstrate some of the many color possibilities of concrete.

Two-Way Reinforced Concrete Floors

All floors will be of two-way reinforced concrete slabs supported upon reinforced concrete beams. In some of the rooms the concrete floor slab will be finished with terrazzo, cement tile or art marble, all demonstrating the latest word in the concrete maker's art. Most of the floors are designed for uniform loading of 100 lbs. per sq. ft. The first floor is designed for 150 lbs. loading because of heavy laboratory equipment; while the floor of the moist room located in the basement will be designed to carry a load of 500 lbs. per sq. ft., because of the great weight of specimens carried in storage for period tests.

In order to carry out the architectural effect of long vertical lines, sash of the casement type having a reveal of only about 2½ in. will be used. The roof is also to be of reinforced concrete and will be covered with a layer of insulation consisting of slab cork 1 in. thick, and will be used also to store specimens that are to be exposed to the weather. Portland cement plaster applied directly on the concrete surfaces or on brick or tile will be used on the interior where the finish is other than cast stone, and will display workmanship of artisans in the plastering craft illustrating the wide variety of surfaces and texture possible through the use of portland cement.

Field Control of Concrete

An unusual feature of the work is the fact that for the first time the specifications will follow throughout the entire work the recently developed methods of field control of concrete. In other words, concrete mixtures will be designed for a definite strength on the basis of the water-cement ratio principle of concrete design developed in the association laboratory.

So far as is known, the Portland Cement Association will be the only association of its kind to own its home. Nearly 23 years of continued progress stands to the credit of the cement industry through the scientific, educational research work for which its 89 members throughout the United States, Canada, Cuba and Mexico maintain the activities of the association. No better evidence of the common acceptance of its objects and aims is needed than the fact that its membership has sufficient confidence in the value of its service to the public to provide a permanent home for its many activities.

Add Story to Ramp Garage in 4 1-2 Days

Here is a story of a speed job that, not so long ago, would have been quite unbelievable—but now—read it for yourself as reprinted by courtesy of "The Pacific Builder and Engineer."

Fighting against time to build an additional story to a seven-floor ramp garage in 4½ days, the Seattle organization of Grant Smith & Co., national contracting firm, established late in June what is thought to be a speed record for reinforced concrete work in commercial building.

To match the rest of the building, the additional story was to be built of reinforced concrete and faced with brick. Steel beams supporting the old roof must be torn away and replaced with heavier steel construction to support a reconstructed roof. Twenty large concrete pillars were to be reinforced over their entire length. Seven hundred and fifty barrels of quick-setting cement and 40 tons of reinforcing steel were used in the concrete work.

Completion of such a project within the half-week allotted was accomplished with one of the finest displays of co-operation between the general contractor and crew, subcontractors and material men in the history of the Northwest, it is stated.

Without warning, the contract was offered Grant Smith & Co. at 10 a. m. Saturday, June 20. There had been no preliminary discussion and the contractors were unprepared. But construction actually was under way two hours later. Two hundred and fifty men were on the job Saturday night. Three hundred worked Sunday and Sunday night. A force of between 200 and 250 worked night and day in 12-hour shifts Monday, Tuesday and Wednesday. At midnight Wednesday the forms had been stripped and the garage owners were reaping their first profit from their additional story. The job had been completed in four and one-half days—schedule time.

Construction was supervised by P. N. Carlson and George E. Teufel aided by a corps of inspectors. As the last form was taken down Carlson remarked that he and Teufel had not slept for 48 hours.

Owners Wanted Speed—Got It

Awakening Saturday morning to the fact that the 600-car storage capacity of their Arena garage was inadequate to meet increasing business and that additional demands would be made upon them during the Foreign Trade Council which was to start the following Wednesday and, for that matter, during the entire convention and tourist season, the owners of the garage decided at that late hour to put an additional story on their building.

At 10 o'clock the contractors, who had originally built the structure in 1917 as a skating rink, and who had remodeled it into a ramp garage last year, were startled by a carte blanche order to build the additional story for occupancy the following Wednesday. It was a challenge seldom given any building organization. It was accepted —and right then things started to happen.

Carlson and Teufel fell to the task of organizing their forces like two generals. Plans of a typical floor of the big garage were rushed to the draughting rooms of Hall & Stevenson, Seattle structural engineers. Working plans were rapidly but carefully prepared, and the quantities taken off.

Rush Order for Workmen, Materials

While the engineers were receiving their instructions men were being pulled off other jobs under way by the same company. Union labor headquarters received instructions to forward skilled workmen and laborers to the job. Crowe-Matthews Company, local distributor for the recently introduced Lumnite cement, was instructed to send 600 barrels of cement to the building. The Pacific Coast Steel Company rushed an initial order of column reinforcing steel to the scene.

By noon workmen were paving the way for the initial work—the reinforcing of twenty huge pillars.

By noon, two hours after they were first notified that the work must be done, Carlson and Teufel had their plans prepared, quantities taken off, their working organization rapidly forming and plans completed for carrying the work forward under forced draft on a 24-hour day schedule. They were getting a real perspective of their task.

Steel Delivered on Schedule

At this time two problems faced them. First was the question of getting 40 tons of reinforcing steel delivered as needed. This problem was promptly solved by the Pacific Coast Steel Company—which found itself working Saturday night and Sunday in order to get the steel to the contractors on schedule. Hofius Steel & Equipment Company promptly furnished the structural steel as needed.

The biggest problem was furnished by the scarcity of Lumnite cement. The Crowe-Matthews Company stripped their warehouse, getting a total of 100 barrels on the job early Saturday afternoon. Five hundred barrels were borrowed by long distance telephone from Henry & McFee, handling the $1,500,000 pier in the U. S. Navy Yard at Bremerton. This quantity was loaded on a scow, towed to Seattle and delivered on the job Sunday afternoon and Sunday night, just in time to meet the demands of the concrete mixers.

Monday night it was obvious that more Lumnite cement would be needed. This cement, which sets at full strength within 24 hours after pouring, was the only cement that could be used on a rush order of this kind. None was in stock and no more could be spared by the only firm on this part of the coast who was using a large supply—Henry & McFee.

Had to Have Lumnite—So They Got It

Tuesday the last bags were being used. It looked like a shut-down was inevitable. Then the *S. S. Iowan* docked in Seattle. In a bottom hold was a quantity of Lumnite cement consigned to the Bremerton project. The skipper of the *Iowan* was prevailed upon to open his hatches, dig through his cargo and unload 150 barrels of Lumnite for the Seattle job. Trucks again backed into the garage with cement just at the crucial moment.

Work progressed rapidly. On the evening of the day work was started the 20 pillars were being reinforced. Sunday saw this job about completed and construction of the roof well under way. Monday the 12-ft. concrete walls were being built and Tuesday floor slabs were being completed. A force of between 30 and 40 bricklayers performed magic in completing the outside wall. Wednesday afternoon the stripping process was well under way and Wednesday night the automobiles of delegates to the Foreign Trade Council were safely stowed away in the new eighth floor.

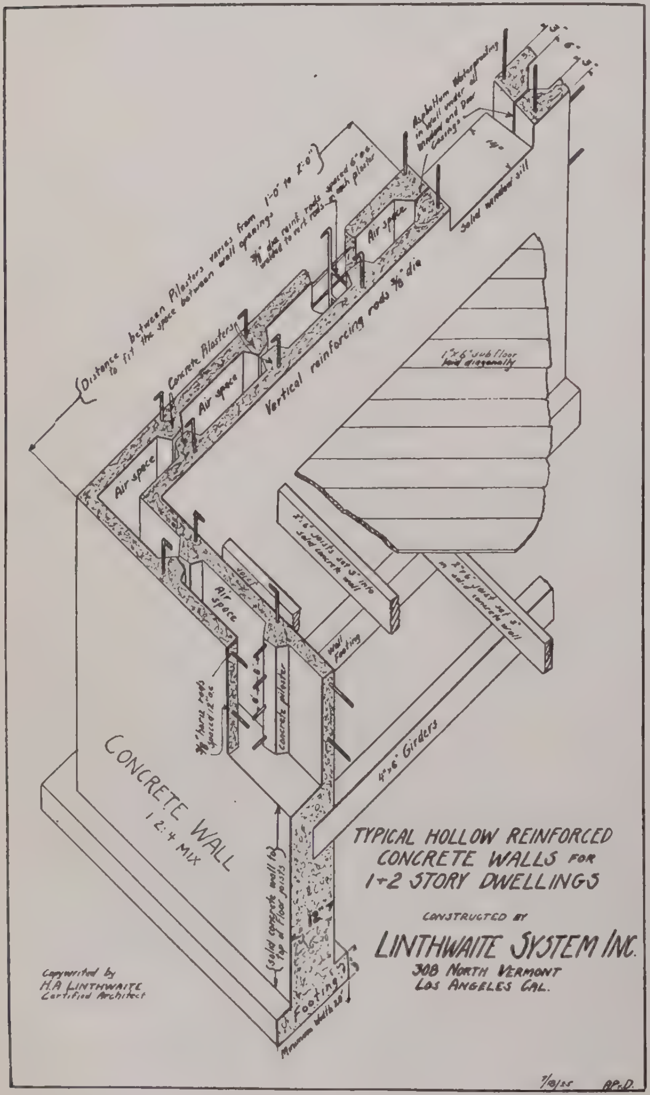
The center portion of the roof was utilized, forming part of the new roof, built on steel trusses, covered with galvanized sheets and covered with tar and gravel.

Co-operation of the subcontractors and material men played a big part in the four-day project.

Architect Designs Concrete House Construction

H. A. Linthwaite, architect, Los Angeles, Cal., has designed a hollow wall reinforced concrete system of construction for residential work, together with a system of steel forms for erecting the hollow walls called for in his design. Literature received by the editors describes the system as a practical affair that has been used with success in constructing the residence of Donald B. Parkinson, architect, and other homes in Los Angeles.

The Linthwaite system of construction affords a method, it is said, to erect a monolithic concrete house, with wood floors and roof, for a cost that is hardly more than that for an ordinary frame and stucco building. The usual type of wall constructed by the system is 12 inches thick. It is composed of two 3-in. walls separated by a 6-in. air space. At intervals, depending upon the structural requirements of the building but usually on 12 to 24-in. centers, the walls are thickened out on the inside to form pilasters that almost meet at the center of the dead-air space. These pilasters carry most of the load on the wall, and give the action of columns, and somewhat the same action as the web of an I-beam, affording the wall additional lateral strength.


Distance between Pilasters varies from 1'-0" to 2'-0" to fit the space between wall openings
3/8" dia reinf. rods spaced 6" o.c. welded to vert. rods in each pilaster
Asphaltum Waterproofing in Wall under all Window and Door Casings
3"
6"
3"
Solid window sill
Air space
Concrete Pilasters
Air space
Air space
Vertical reinforcing rods 3/8" dia
1"x6" sub floor laid diagonally
2"x6" joists set 3" into solid concrete wall
2"x6" joist set 3" in solid concrete wall
Air space
Joist
Wall Footing
3/8" horiz. rods spaced 12" o.c.
Concrete pilaster
4"x6" Girders
CONCRETE WALL
1:2:4 MIX
solid concrete wall to top of floor joists
Footing
Minimum width 20"
12"

TYPICAL HOLLOW REINFORCED CONCRETE WALLS FOR 1+2 STORY DWELLINGS

CONSTRUCTED BY

LINTHWAITE SYSTEM INC.
308 NORTH VERMONT
LOS ANGELES CAL.

Copywrited by
H.A. LINTHWAITE
Certified Architect

7/13/25 AP.D.

Through these pilasters, at intervals of six to eight inches, horizontal steel rods are embedded which are welded to vertical reinforcing bars in the walls. They securely bind the two walls together and further add lateral strength to the pilasters. In each of the walls there are horizontal reinforcing rods 12 in. on centers, and vertical rods not more than 24 in. on centers.

Using the metal forms that have been designed for the purpose the walls are molded course on course, taking care to bond all construction joints, and erect a monolithic wall with adequate reinforcing at all points. Girders and joists are cast into the wall as the work progresses and are afforded ample anchorage. In the construction of the building footings are first poured in the usual manner, a solid 12-in. or thicker foundation wall is carried up to the level of the top of the floor joists, and then the double wall started with the special forms.

Pilasters Carry the Load

Pilasters are spaced to frame all wall openings, and the interstices between the two abutting pilasters at each side of these openings are caulked with an asphaltum waterproofing. Window sills are cast solid with a 2-in. overhang. Reinforcing steel is usually 3/8-in. rounds and spaced according to requirements. A 1:2:4 concrete is usually specified.

This system, while primarily designed for the construction of small dwellings, has been used with apparent success in the erection of small business buildings, large residences and duplex houses as well. In the climate of Los Angeles the houses are warm and dry in winter and cool in summer. They are said to be quite stable and are thought by the designer to be earthquake-proof and tornado-proof, as well as fireproof. The walls as formed are said to be remarkably smooth and need a minimum of finishing or plastering.

Both the system of construction and the forms for use in erection have been covered by patents, which are held by the Linthwaite System, Inc., of Los Angeles. That firm is now taking contracts for the erection of all types of small buildings in their territory by means of the system.

What Highway Research Is

By A. N. JOHNSON

Chairman, Highway Research Board of the National Research Council

Research differs from engineering practice in that the research worker has no precedent from previous experience to guide him. He may be wholly unaware of the significance of his results, for these are often of vital concern and mankind will benefit by his discovery.

The tremendous increase in road building has caused the highway engineer to focus his attention on research to help him solve the problem of constructing and maintaining roads to take care of the demands of traffic.

The result of such investigations as the Bates, Pittsburgh and the Arlington experimental roads have been of great value to road builders. The Bates road, costing the state of Illinois about $250,000, has given information that resulted in a modified cross-section for concrete roads that, while strengthening the road slab to carry traffic, also resulted in a saving in the cost of construction due to lessening the amount of concrete used.

Research conducted by the U. S. Bureau of Public Roads and other agencies has resulted in the more economical design of roads and has pointed the way to better methods of construction.

The work of the researcher is essentially different from that of the practicing engineer. The engineer plans definitely for a specific purpose or end. The facts and conditions are assembled and known; then the means are devised for executing the work to be done. Not so with the researcher. While sometimes he may have a desired end to attain, often there are no facts or definitely known conditions at hand. There is no precedent from previous experience to guide him. No evidence or fact is too trivial to escape his notice. He may not be at all sure that the plan of investigation upon which he embarks will arrive at a definite port. Again, he may be wholly unaware of the significance or the application of the facts that he has brought to light, but, because of his research, someone, at some time, will make the discovery that these facts are of vital concern to mankind.

Research of this character can best be illustrated by an incident in connection with the work of the German chemist, Nageli, who lived about 100 years ago. He was studying the reproduction of cells, and for this purpose used a form of algae. He desired to cultivate them in his laboratory which he had improvised in his kitchen. This he was unable to do. The algae, as soon as placed in the water in the laboratory, died for some unexplained reason. After careful observation he noted that all the algae placed in water drawn from a copper spigot died. Others placed in water not drawn through the spigot lived. He concluded that the minute amount of copper contained in the water caused the death of the algae. Further experiment proved this to be true; and that so small a portion as one part in 50,000,000 was sufficient to destroy the algae life. But it was not until nearly 75 years later that sanitary engineers made use of this knowledge in the purification of water supplies. It was further discovered that the copper which killed the algae also killed many harmful forms of bacillus life. Thus, upon the observations recorded by the German chemist 75 years previous, the health of city dwellers the world over was protected.

I bring this illustration to emphasize the fact that research work is, of necessity, done on a different basis than the engineering work with which you and I are most familiar.

Value of Research

The value of research work in modern commercial life is evidenced by the fact that so many of the great industries have many millions of dollars invested and spend many thousands yearly in the maintenance of elaborately equipped laboratories in charge of scientists of the widest reputation, to seek facts, to discover new methods or processes, by investigating patiently a thousand different methods in order to arrive at one which may prove practical in commercial and every-day activities. So, too, in the great industry of highway transportation, there is equal need and equal value for research.

Development in Highway Transportation

Seldom has there been experienced in so short a time such a great economic development as we have witnessed in highway transportation. This development has brought into existence thousands of miles of improved highways and millions of vehicles, totaling an annual expenditure of such huge sums that they almost lose meaning for want of a comparison by which they may be measured. For the construction of roads alone we are spending over a billion dollars a year and several more billions for the manufacture, upkeep and operation of the vehicles. It is not hard to conceive that this should raise a wide variety of problems that call for a great diversity of talent for their study and solution, problems for the economist and the engineer, the physicist and the politician.

The State Highway Departments found themselves suddenly called upon to expend millions, where thousands had sufficed. Heavy loads at high speeds had to be carried. Experimental work was undertaken.

The Highway Research Board

In the effort to help to co-ordinate not only investigations that had been undertaken, but to outline the field that was opening for research in the development of highway transportation, the Highway Research Board of the National Research Council was organized, of which Charles M. Upham is director. Through its effort there has been fostered increasing active participation by the state universities, where, naturally, much of the work of this character could best be done, provided there was some way to find out what should be done and who could do it.

It is not easy to point, at this early date, specifically to the economic saving that may have been so far effected by these highway researches.

A carefully compiled list of these projects has been made by the Highway Research Board, totaling in number 479, divided as follows:

State highway investigations	205
University investigations	184
Municipal, county, industrial	90

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[1] From an address delivered at a meeting of the North Carolina Section of the American Society of Civil Engineers, Asheville, N. C.

It is a part of the work of the Highway Research Board to put this mass of information, resulting from these researches, in such form as will impress the public with the material value and necessity of work of this character in the highway field. The fact that, at present, we do not know the exact money value that can be named as the result of these particular researches is not particularly significant. But what is of significance is that there have been programs of research inaugurated in many states that cover a wide field.

Foremost among these are the investigations that have been carried on by the U. S. Bureau of Public Roads, many of which have been in co-operation with the State Highway Departments. The bureau's investigations into sub-grade conditions, that may be considered as fundamental in the design of our highways, have gone already far enough to point out clearly certain forms of construction that should be followed, and that others on which much had been expended in the past were of small value.

A very interesting economic study has been made in Wisconsin under the direction of the State Highway Department, where it has been learned that tourists in Wisconsin spend yearly, within the state, $80,000,000, the profit on this amount of business being much more than the state spends on its road system.

State Highway Research

As illustrative of the extent to which some of the states have undertaken highway research problems, may be cited what is known as the Bates test road in Illinois. This project was carried out by the State Highway Department of Illinois, of which Clifford Older was chief engineer, in co-operation with the U. S. Bureau of Public Roads, of which T. H. MacDonald is chief. The state expended on this experiment $250,000, a large sum for building purely a test structure. One outcome of these tests was a modification of the cross-section for concrete roads in the state, lessening the amount of concrete used, while strengthening the road slabs to carry traffic; a saving on the road program, then actually in hand in Illinois of over $2,000,000.

The extensive series of tests undertaken at Pittsburg, Cal., is another illustration of the high grade scientific work that is being done in connection with highway research. This investigation was a co-operative effort between the State Highway Commission of California, of which A. B. Fletcher was state highway engineer, and the U. S. Bureau of Public Roads.

For this investigation there was constructed a track, with parallel sides and circular ends of 75 ft. radius, a total distance of a little over 1136 ft., on which was concentrated in 89 days over seven and one-third million tons of traffic. This amount of traffic may be better visualized by the fact that a road with an average distribution of truck traffic of 1000 trucks per day would require something over 12 years to carry the tonnage applied on the Pittsburg test road.

The Results Checked

The road itself was of concrete construction of various types, special care being taken to install apparatus that made it possible to observe the effect of traffic upon the road slab. It is impossible in this running summary to do more than to refer those interested to the excellent report of this research issued by the Department of Public Works of California, under the title, "Report of Highway Research at Pittsburg, Cal., 1921-1922." It is significant that many of the phenomena, particularly the curling or vertical movement of the road slab during a change in temperature of the top and bottom of the slabs, noted in the Pittsburg road test, are also recorded in the observations made on the Bates road test and those made at Arlington, Va., by the Bureau of Public Roads.

In North Carolina notable work has been done under the guidance of C. M. Upham, chief engineer of the State Highway Commission. After a careful study of what had been done elsewhere, and through building sections of road experimental in character, there has finally been developed a form of road construction suitable for a considerable amount of light traffic, which has a great potential value in the development of many of the poorer and sparsely settled sections of the state. This has been brought about through the development of an inexpensive type of road surface, taking advantage of the sandy character of the soil which prevails in much of the region traversed by these roads.

Use of Highways Should Be Studied

Investigation and research are needed to study how best to use the highways; what are the proper regulations. First, that we may safeguard life and limb; second, that we may expedite the flow of traffic over the highways. There is no more serious problem before us than that of highway safety. Our highway traffic accidents have reached the appalling yearly total of over 23,000 lives and more than 600,000 persons maimed and injured. We almost ask ourselves if we have not created a Frankenstein.

Probably no more perplexing problem is presented than that of traffic congestion today. We provide radial or arterial roads which concentrate such a large flow of traffic at given points as of itself to cause stagnation through these centers. We may bring traffic readily and rapidly to the confines of a city only to discover that there is not traffic area sufficient to take care of the volume that has been so attracted. Eventually, this must cause so great inconvenience as to reduce the amount of traffic. The problem before us is to determine, if possible, what may be the ultimate flow of this highway traffic, and the provisions that should be made for its accommodation. What may very likely happen is the essential readjustment of the distribution of population tending to disperse it rather than continue concentration as has been the case for so many years, and witnessed by the upbuilding of our great cities.

Universities Could Aid

Perhaps enough has been said to indicate the character and value of research work in general, and in particular that we have many grave and pressing problems in highway transportation that call for co-operation of every available agency. Our universities, with their splendid equipment of men and laboratories, can probably be used to greater advantage. A very important part of the work of the Highway Research Board will be to arouse the interest of the various agencies in these problems.

The Highway Research Board also has a number of researches under way which are financed by industrial concerns and there is little doubt but that the program of researches so financed will soon be much enlarged.

This may be expected because the opportunity presented for this character of co-operation, through the organization of the Highway Research Board of the National Research Council, furnishes unique auspices under which such work may be carried on that is scientific in character and impartial in its findings.

Fundamental Business Considerations in Concrete Products Manufacture

There is little here that will be new to the experienced manufacturer of concrete building units, but some worth-while considerations for the beginner or the man about to go into the business.

Many new concrete products plants are being constructed and many old plants enlarged or rebuilt. It is timely, therefore, that even the capable manufacturer gives thought to important fundamental factors in the business.

Before enlarging in the manufacture of concrete products, make a very careful study of the extent of the market. In the city the establishment of a factory specializing on building units such as concrete block or building tile is generally feasible, while in the small town a plant might have to manufacture a variety of units to provide a sufficient volume of business to render it profitable. It is generally inadvisable for a products factory to go into business in a location where other plants are already in operation with ample capacity to care for all demands. If a definite but undeveloped market is within the selling radius of a proposed plant, it is unwise to erect a plant unless sufficient funds are available to develop the market. The concrete products industry is in its infancy, the market for concrete building units is continually expanding, but foresight is necessary in selecting the type of products to be made and in estimating the extent of the potential market.

Location of Plant

The location of a plant is important because of its relation to the cost of transporting both the raw materials and the manufactured products. These costs are continuous and losses due to poor location accumulate rapidly. Generally, if products are to be sold locally, a site near the center of the market is preferable. A location at the source of aggregate supply and yet within the market limits is especially good. When aggregates are shipped in or products are shipped out, trackage is advisable even at considerable initial expense. In case the market covers a large territory, several small plants may be more economical than one large one. If aggregates are not available near the market, a plant site near the market is generally preferable since freight rates on finished products are higher than on raw materials. In a city location, the direction of probable future development of the city should be taken into account, so that the market will approach rather than recede from the point of manufacture. Central locations have an advertising advantage and permit the manufacturer a close contact with his customers.

Costs

In order to arrive at a reasonable selling price for any manufactured article the actual cost of production must be accurately known. Because of the great variety of conditions peculiar to each plant it is impossible to specify in detail a system to be generally adopted. The cost system should be as simple as possible. The daily labor sheet should not only record the time and cost of labor but the work performed by each man. Records of materials received and used should not only cover the principal items, such as cement and aggregates, but all supplies such as machine oil, oil for use on molds, special reinforcing steel, coloring materials, etc. Accurate records of all products made, those delivered and breakage should show the exact number of each in the stock pile at the end of each day. The daily reports should be filled out by the man in charge of plant operation. Costs of transportation of materials to the plant are rightfully figured in manufacturing cost. Indirect costs include salary of manager, fuel, power, depreciation of plant, insurance, taxes, rent, etc. Depreciation of building is usually considered about 5% and of machinery as 20 to 25%. Do not overlook office and sales expense, interest on investment, advertising, telephone, printing, etc., and miscellaneous expenses. If the prospective manufacturer is inexperienced in cost accounting, it will pay him to obtain the services of an expert accountant to install his system. Correct costs often show where undue expense is being incurred and such leaks can be stopped. Too often selling prices are based upon direct costs only, resulting in the fixing of a selling price below actual cost of production.

Layout of Plant

A well arranged plant reduces labor costs. The plant should be laid out with a view to keeping all materials moving forward in a straight line from the time the raw materials are taken from the bins until the block are delivered in the yard. A compact arrangement saves both floor space and labor. Very frequently increased business requires the enlargement of a products plant, and the original layout should be such that enlargement can be made without rearrangement of the machinery already installed. Cement storage, aggregate bins, office and heating plant can easily be located so as to be convenient for use in an enlarged plant. Factory floor space should be available for making concrete sills, lintels and special units so that the manufacturer can furnish all materials for the wall area of concrete masonry structures. Use gravity for moving materials whenever possible. Overhead bins for storage of cement and aggregate affords the opportunity to employ gravity fully. Occasionally advantage can be taken of a side-hill location to accomplish the same result. A floor slope of ⅛ in. to the foot from the machines through the curing rooms is sufficient for

How George D. Barriball keeps his stock yard looking neat and trim and inside this plant is neater and cleaner than most bakeries easy movement of trucks or cars on a smooth hard concrete surface or industrial tracks.

Plant Equipment

Machinery and equipment that will give production at low cost per unit should be selected. The cost of a piece of equipment is measured by its capacity and the service it will render. Where possible, the actual production of machines in operation should be checked up together with the number of men required to operate them. All concrete machinery receives hard usage and lightly built machines soon depreciate. Extra parts which are subjected to heavy wear or which are likely to break should be carried on hand. Most concrete product machines are capable of making good products but no machine can, by the excellence of its operation, make quality units with a relatively lean mixture or improper manufacturing methods. Sometimes it may be more economical to operate two small units than a large one, particularly if the latter is operated intermittently. It is important that conveyors, cars and other equipment are not left in the yard exposed to the weather, that belts and machinery are arranged to reduce liability of accident to a minimum, that machinery be kept in adjustment and well oiled and that exposed bearings and gears be protected from dust and dirt. Time set aside to clean and oil all machinery at the end of each day's work will pay good dividends. When steam curing is used, the night fireman can do this work. Reasonable care of machinery pays.

Ample storage space for cement and aggregate may prevent costly shutdowns in times of car shortage or other temporary delays in replenishing supplies. Concrete storage bins of the silo type have proven satisfactory and economical. An adequate stockpile of aggregate is essential for manufacturing products in winter where aggregate is not available during the cold weather.

Labor

Watch the labor cost closely—it is a big item of expense. Strive for the maximum output per man, installing labor saving devices and equipment whenever they will lower the cost of production. Conveyors to carry raw materials to mixer or to overhead bins, and trucks and cars to take products from machines are found in the most efficiently operated plants. Car-lift trucks with racks, suspended monorail systems and industrial cars on steel tracks are satisfactory types of off bearing equipment.

Overhead

Overhead costs should be kept as low as possible and are correctly based on the output of the plant. This is just as important in a small plant as in a large plant. A large investment in factory and equipment must be balanced by large production. If production is large, overhead costs per unit may be low even though considerable capital is invested in the business. Likewise, overhead costs may be high in a plant of small capacity where the investment is low.

All Year Round Operation

Very often products plants unable to supply demands during the spring and summer are closed during the winter. Many plants carry so small a surplus that a short delay in the receipt of materials in mid-summer when car shortages are prevalent completely depletes stock and reduces sales. In most cases, continuous production during the winter will increase profits even though the plant is not operated at full capacity. Well arranged, winter work can be carried on with little additional expense. Materials are then somewhat cheaper and good workmen can be retained by providing continuous work. Spring deliveries can be made with well seasoned stock. If products manufacturers do not have the funds to carry a large stock, detailed records of their business generally will be helpful in obtaining loans from banks for this purpose. Such records must show that it will be profitable to prepare in advance for the construction period rush.

Keep the stock yard arranged neatly with blocks and tile piled so that they will present the best appearance and expedite loading for delivery. All culls and broken pieces should be disposed of immediately.

Show your own faith in your product by constructing your home, your office and factory of concrete block or tile.

Helping the Newspapers Get the Facts

Don't Try to Get "Puffs"— But Get the Confidence of the Newspaper Men

By ALLEN L. ROSS

"Why Biscuits Are Hard: Cement Blocks Are Made Similarly" was the title, running clear across the page, of a feature story about a reporter's interesting visit to the Shillington Cement Block Works, as run by a Reading, Pa., Sunday paper.

It had local interest; undoubtedly it was read by many.

"Believes Concrete Floors May Be Cause of Epidemic" was the headline in a California paper.

It, too, had local interest and undoubtedly it was read by many. Again!

"*Cement Floors*—Often Contribute to Children's Ailments, Says M. O. H"—the headline in an Ontario paper, and it had local interest that would appeal to many.

There may have been corrections of these last two stories. I didn't see any corrections and if there were any, many persons who saw the originals would miss the corrections. Perhaps the stories were clipped and sent to some national organization and some time later a letter of explanation or denial that concrete is injurious and unhealthful was tucked away in an obscure corner of the paper.

Either way, the stable was locked after the horse was stolen. I'm speaking from the newspaper standpoint. I want to point out to every man connected with the concrete industry that the more newspaper reporters you have writing interesting facts about concrete construction the less likelihood there is of wrong ideas about concrete getting into print. The newspapers will know better. You don't have to cajole newspapers or attempt to bribe them with advertising. Most newspaper men are honest.

They thirst for interesting facts. If you have helped a newspaper man write an interesting feature story the chances are good that you may be consulted before any story which might reflect on concrete gets into print.

Concrete contractors can do something that no national organization can do, no matter how efficient it is and something that cannot be done by the pressure of an advertiser. The individual contractor can make friends of newspaper men and they will have a better understanding of his business.

That story the Pennsylvania reporter wrote shows that there is more interest in concrete than those who are so close to it realize. He even made it interesting to women by comparing block-making to bread-making. And sometimes women have something to say in construction matters.

My suggestion, based on newspaper experience, is for concrete men to become acquainted with newspaper reporters. If there were plenty of favorable *local* material about concrete printed, the unfavorable material would be overshadowed or crowded out. Understand that I am not talking about publicity matter, telling in a general way about the advantages of concrete. Most such stuff hits the wastebasket immediately. I mean *local* stories about how concrete is being used.

There are, as a rule, no channels of contact between concrete contractors and newspapers which would bring out the best material. If competent newspapermen, or even newspaperwomen, were acquainted, some interesting things about the part concrete plays in our lives likely would be uncovered and printed. It would be good stuff, too, because the writer would be enthusiastic about it.

In most communities, the contractor's place of business is not covered by the newspaper. Contrary to common belief, newspaper reporters do not go hither and thither seeking news. Most of them are assigned to regular "beats." As only the places likely to have news regularly are on these "beats" or 'runs," contractors' offices more often than not are not included.

Anyway, few stories would be uncovered in the routine manner. Few contractors know what interests the newspapers. The best stories come from friendly conversations, when the contractor who is too close to his work to know its interest tells something interesting. Good reporters like to dig up topics for "time copy" stories, or articles, as you might call them. "Time copy" stories are those that do not have to be rushed into print, but can be set in type when the compositors are less rushed and the papers least full of big stuff. They can be used any time to fill up pages that are sent to the plate makers early in the morning or evening or used in the Sunday issues to help carry the heavy volume of advertising. In short, if live contractors and live newspaper folk can become friendly both will benefit.

Make a friend of the newspaper if possible by giving it some news *not connected with your business.* If you see an accident or anything you feel sure is news, call up the city editor and just say you are giving a tip. If it is something that you know quite a little about and you have a stenographer handy, have the facts written out and send it over. Don't ask to have a reporter sent to see you. If more is wanted after you have telephoned or written, the city editor will send a reporter to see you. Many reporters are literally working their legs off and dislike to act as messenger boys for small items. If you ask for a reporter you may get one, as the city editor may not want to chance passing up a story. But the reporter will be your enemy for life because he thinks you have an exaggerated idea of your own importance.

Even though you may not hear from two or three tips you turn in, you are likely to be remembered as friendly. And the paper will be genuinely glad to have you call up, even though they may have had the news from another source. Any legitimate news about your own affairs and your own work will receive consideration, especially if there is no element of "puffery" in it. When any question about concrete comes up you are likely to be consulted. It is the policy of all newspapers to take care of their friends, not in the sense of hushing up news, but in verifying anything likely to be detrimental to their interests and in mentioning them when it can be done legitimately.

Few papers willingly antagonize any industry. If any local paper has a number of friends in the concrete industy, there is likely to be more beneficial than injurious material published. And it will be done without any "pull" or "pressure," but simply because the way for getting at the truth with the least possible resistance has been opened. Some papers have men in different fields, such as electrical, medical, legal and others as a sort of an advisory board. These men are called up whenever any question regarding their field comes up in the news or editorial departments. Maybe there is a suggestion for concrete men in that.

Letting reporters look at concrete jobs is one of the best ways of getting good material published. The reporter will discover the interesting things for himself if you take him around and talk enough—I mean he will suggest to himself that there is the material for an interesting article. But let him suspect that you are trying to work him for a free advertisement and it's all off. If he can assure the city editor that "it's all his own idea," material has a better chance of being published.

It's harder to get what is known as "free publicity" than it used to be. Facts and not "puffs" are what people want in their papers. Help make it easier for newspapers to get the facts about how concrete is performing in their communities. In the long run your business fate rests on facts; any honest business rests on facts so far as they are ascertainable.

The most effective way to diminish the number of undesirable articles about concrete and get good publicity for the industry is for as many individual contractors and as many individual newspaper men as possible to know each other and to respect each other.

A Peculiar Storage House Built of Concrete

In Arlof, Sweden, is a peculiar concrete structure which is used for the storage of brown sugar. A special conveyor in the lantern-like structure of the roof brings the sugar into the building and it is removed, when needed, by means of conveyors built beneath the floor. The roof of the structure has been designed to conform to the angle assumed by the sugar as it falls from the conveyor.

Left—The exterior of the storage house that utilizes every cubic foot for storage purposes. Right—The interior of the sugar warehouse, showing how the slope of the roof conforms to the angle of repose of the sugar, making possible storage up to the roof. Not an inch of this space need be wasted

Cost Data for Concrete Construction Job

The following cost data for jobs completed in the summer of 1924 by the Ferro Concrete Construction Co., Cincinnati, Ohio, has been given out by the company as covering three types of building: flat slab, flat slab ramp system and beam and girder type. The data for the three jobs which are numbered Jobs 4, 5, and 6, are summarized under the headings, Forms; Concrete; and Reinforcing Steel.

Forms

Unit costs are based on square foot of contact surface of forms (round columns and sloping head excluded). In figuring the contact surface of interior beams, no deduction is made for beam and girder intersections, although on exterior lintels framing into large columns, the distance between columns is taken. The area of floor slabs is the gross area inside the outside perimeter of the concrete frame, including the ordinary stair, elevator and smaller openings; larger openings are deducted from this area. Under "Make" the numerator is the cost per square foot for making forms, and the denominator is the average number of times the forms were used, which, with the exception of column heads, is gotten as follows:

	Job No. 4		Job No. 5		Job No. 6	
Sq. ft. of form work erected on job	1,150,000		77,800		135,000	
		= 4		= 3		= 3.4
Sq. ft. of form work made	290,000		25,000		40,000	

The use of column heads is based on the number of floors and roof, as a set for one floor is furnished.

Labor scales—see below; Job No. 4—strike and formation of new Carpenter Union increased the cost of 2nd and 3rd floors.

Job No. 4 Flat Slab Labor Rates	Misc. Erect	Beams Make	Beams Erect	Square Cols. Make	Square Cols. Erect	Shoring* Erect	Panels* Make	Panels* Erect	Drop Heads Each Make	Drop Heads Each Erect
Common Carpenter										
$.50 —$1.10 Footings	$.115									
.50 — 1.10 Walls	.147									
.55 — 1.20 1st fl. (4-ft. shores)			$.191		$.216	$.058		$.028		
.50 — 1.10 2nd fl. (high story) strike			.22		.16	.081		.032		$2.77
.50 — 1.10 3rd fl.			.23		.25	.057		.028		3.98
.52½— 1.15 4th fl.			.18		.19	.044		.026		4.60
.52½— 1.15 5th fl.			.168		.214	.044		.028		4.40
.52½— 1.15 6th fl.			.176		.216	.046		.029		3.53
.52½— 1.15 7th fl.			.129		.25	.046		.027		4.22
.52½— 1.15 Roof			.24		.21	.054		.028		5.21
Average			.191		.213	.053		.028		4.10

Average making .012 (not kept separate for each class of work).

Job No. 5 Flat Slab Ramp System	Misc. Erect	Beams Make	Beams Erect	Square Cols. Make	Square Cols. Erect	Shoring* Erect	Panels* Make	Panels* Erect	Drop Heads Each Make	Drop Heads Each Erect
Footings	.192									
Walls	.125									
"A" Floor (half)						.044		.040		5.15
"B" Floor (full)			.160		.091	.058		.034		5.31
"C" Floor (full)			.168		.094	.034		.044		5.69
$.55 — 1.20			.164		.086	.045		.039		5.38
Average		$\frac{052}{3} = .011$		$\frac{.041}{3} = .014$			$\frac{.016}{3} = .005$		$\frac{6.32}{2.5} = 2.50$	

Job No. 6 Beam and Girder	Misc. Erect	Beams Make	Beams Erect	Square Cols. Make	Square Cols. Erect	Shoring* Erect	Panels* Make	Panels* Erect	Drop Heads Each Make	Drop Heads Each Erect
Footings and Walls	.139					*				
$.52½— 1.15 1st fl.			.180		.212	.....		.057		—
.52½— 1.15 2nd fl.			.187		.169	.....		.054		—
.52½— 1.15 3rd fl.			.182		.161	.....		.067		—
.52½— 1.15 4th fl.			.183		.170	.....		.060		—
.55 — 1.20 5th fl.			.169		.186	.....		.063		—
.55 — 1.20 6th fl.			.190		.140	.....		.046		—
.56 — 1.20 7th fl.			.166		.185	.....		.065		—
.55 — 1.20 8th fl.			.170		.170	.....		.059		—
.55 — 1.20 Roof			.250		.270	.....		.055		—
			.186		.185	.....		.060		
Average		$\frac{043}{3.4} = .012$		$\frac{.051}{3.4} = .015$			$\frac{.012}{3.4} = .004$			

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*In Job 6 shoring costs are included in beam costs. Where shoring and panel costs are given, they are figured on square feet of floor area.

Forms

	Wood Forms: Job No. 4	Wood Forms: Job No. 5	Wood Forms: Job No. 6	Cost per Col. for Round Col. (Metal): Job 4 Under 2nd	Cost per Col. for Round Col. (Metal): Job 4 3rd Up	Cost per Col. for Round Col. (Metal): Job 5
Erect job equip. for forms	$.003	$.004	$.003	......	......	......
Unload and reload salvage	.007	.015	.006	$ .19	$ .19	$ .25
Erect weighted avg. of Sheet No. 1	.120	.110	.130	9.50	4.49	5.08
Wreck	.011	.019	.023	1.92	.88	1.26
Clean up form rubbish	.005	.004	.006			
Making at shop weighted average of Sheet No. 1	.....	.010	.014			
Making at job weighted average of Sheet No. 1	.012	.006				
Total labor	.158	.168	.182	11.61	5.56	6.59
Power and upkeep sawmill	.002	.005	.006			
Materials	.043	.070	.055			
Total average cost per sq. ft.	.203	.243	.243			

Concrete

Labor Scale: See Forms
Materials: Cement Sand Stone delivered by truck
Plant Job 5-6: Similar to Type 1 Pg. 370 American Concrete Inst. Proceedings 1923
Job 4: Similar to Type 5 Pg. 370 American Concrete Inst. Proceedings 1923

	Yds.	Yds.	Yds.
Yardage—(concrete only)	31,470	2210	2560
	Chute	Chute and Wheel	Wheel
Set equipment	$ .42	$ .90	$ .49
Unload sand and stone	.04	.13	.28
Unload cement	.12	.17	.09
Mix	.40	.71	.65
Place	.46	.68	.55
Point, clean up, etc.	.65	.55	1.07
Move chutes	.05	.08	.....
Total—Unit labor per yd. of concrete	2.14	3.22	3.13
Coal Htg. and Misc.	.35	.16	.40
Tools and tarpaulins (net)	.28	.30	.40
Hauling equipment	.04	.07	.10
Water line	.02	.02	.01
Miscellaneous materials per yd. concrete	.69	.55	.91

Reinforcing Steel

Labor Scale: Job. No. 5-6 truck delivery. Job No. 4 unloaded from cars
Job No. 4, $.90 to .95; Job No. 5, $1; Job No. 6, $.95 to $1

	Job No. 4	Job No. 5	Job No. 6
Spiral steel—cwt.	3328	16	.—
Bars	35818	1965	4377
Total cwt.	39146	1981	4377
Equipment	$ .04	$ .01	$ .06
Unload	.09	.05	.06
Bending	.32	.14	.17
Place	.87	.99	.97
Making concrete blocks	.....	.04	—
Labor per cwt.	$1.32	$1.23	$1.26
Cost of spacers, chairs, etc.	.10	.04	.06
Hauling	.....	.08	.08
	.10	.12	.14

Industrial Engineering Course

Cross-breeding the engineer with the business administrator is the interesting experiment that will be launched at Lehigh University next September, according to a recent announcement of the inauguration of a new curriculum to be known as Industrial Engineering. Recognizing that every modern enterprise depends on sound financing, adequate accounting and intelligent forecasting of economic developments, the faculty at Lehigh will undertake to produce engineers as thoroughly grounded in these fundamentals of business as in their mathematics, physics and scientific subjects. The curriculum is primarily engineering in character and will equip the student with sufficient technical knowledge to make him at home in a highly technical environment. In addition, however, it will include courses in economics and business that will be of service to those graduates who enter the less technical department of any of the various industries which are essentially technical in character.

Novel Concrete Street Work in Santa Monica

By MICHAEL J. PHILLIPS

So far as known in Southern California, City Engineer Howard Carter, of Santa Monica, has evolved something entirely new in the way of concrete construction. He is using a column and beam device to meet a perplexing situation which has no counterpart.

Santa Monica is built on a high bench which drops rather abruptly toward the sea and to another and narrower bench. A depression of considerable dimensions has resulted. In the past, during the formative days, it was customary to avoid fills as much as possible and to pave the streets at nearly, if not quite, the natural grade through this depression. Growth of automobile traffic, however, has caused the city to reduce grades and make fills generally in the paved district.

One of the most notable examples of following the natural grade through the depression between the benches is on Colorado Avenue between Ocean Avenue and Fourth Street. At the deepest point Colorado Avenue is 12 ft. below grade. Two intersections, Second and Third Streets, come in at considerable depth. The city is bringing Colorado Avenue up to the Ocean Avenue-Fourth Street grade, incidentally burying the present pavement beneath a fill of about 50,000 yds. of earth.

This, however, is simple engineering and not much of a problem. The earth is secured from another city job less than a mile away, where a heavy cut is being made. The new pavement will be 60 ft. in width and will consist of 3 in. of asphaltic concrete and 2 in. of bitulithic. The pioneering concrete work is incidental to the main job.

For 320 ft. northeasterly on Colorado Avenue from Ocean Avenue the street is retained by a reinforced concrete cantilever type retaining wall. Mr. Carter made a careful study of the construction and came to the conclusion that the wall is not of sufficient design to carry the additional load which the new fill creates.

To remove the wall and replace it with a new one of the proper strength would cost, according to the contractors, about $50,000. This would be extremely burdensome to property owners, ten of whom will be put to heavy expense to raise their homes to the new street grade. So, to save them as much outlay, the city engineer set his wits to work.

There is a sidewalk space of ten feet which runs the entire length of the wall. Under the plans prepared this width will be retained. Mr. Carter saw that a new method of bringing the old wall to grade, while making it perfectly safe, was his problem.

So he is extending the old wall up to the new grade with a reinforced column and beam construction. Columns are tied together with a longitudinal concrete beam at the top. The beam will carry an ornamental coping surmounted by an iron pipe guardrail galvanized. Some portions of the old wall will be taken out, but only enough to allow a thorough bond of the new columns to the old work.

On the outer, or street side of the sidewalk space, is a curb line. A reinforced cantilever type of retaining wall is being built to retain the new earth fill. The retaining wall is tied to the column and beam construction with a reinforced concrete slab which serves as a sidewalk.

The advantage of the new construction is that it eliminates a great deal of filling. Consequently the pressure on the old wall is materially lessened. The design shows that the resultant caused by the new fill and acting on the wall strike below the footings of the old wall. Thereby the old wall is relieved of any additional load, except the dead load of slab, column and beam construction.

The Idea Saved $42,000

When Mr. Carter made his drawings and called for bids on the new construction, the lowest bid was $8,000, and this has been accepted, making a clear gain to the property holders in construction costs of $42,000.

It so happens that the novel construction is on the property line of a very valuable plot of ground. Naturally, any construction of this kind is not designed to assist in the foundation work of a private building. After a building has been erected on the property the retaining wall construction becomes practically useless, since the foundation of the building retains the street.

In this instance the construction works out as a decided advantage to the property owner. Because the area created by the new construction under the sidewalk acts as additional basement space and provides openings for commercial elevators which will be used in the sidewalks.

Nature of Rerolled Reinforcing Bars

By C. L. VOLKMAN

It has become the common measure of a structural material to state the product of the strength by the elongation. The specifications of the American Society for Testing Materials for boiler riveted steel state that the elongation in 8 in. in per cent shall be 1,500,000 divided by the tensile strength. For hard grade billet steel concrete reinforcement bars 1,200,000 divided by the tensile strength; for rail steel concrete reinforcement bars 1,200,000 pounds over the tensile strength.

This criterion of material was introduced by the famous testing engineer, Tetmajer. His criterion was that the per cent of elongation should equal 1,500,000 divided by the tensile strength. The late Professor H. M. Howe shows in his book on the metallurgy of steel that the least allowable elongation for various grades of steel should be approximately 1,000,000 divided by the tensile strength, and the greatest elongation would be aproximately 1,600,000 over the tensile strength.

In 1913 the Committee A-1 of the American Society for Testing Materials investigated the rail steel product from five different mills, collecting over 2,000 samples of reinforcing bars rolled from steel rails. These bars were of various sizes and shapes, originating from the head, the web and the base of the rails. The elongation of the plain and deformed bars ranged from 1,600,000 to 2,000,000 divided by the tensile strength. In other words, this rail steel had excess ductility over that to be expected of high strength steel.

The strength of these plain and deformed samples ranged from 98,600 to 108,500 lbs. per sq. in., the yield point from 50,000 to 75,000 lbs. per sq. in. and the elongation in per cent from 15 to 20 per cent, stated as averages.

The conclusion of the committee of the A. S. T. M. was that this material was of sufficient quality and uniformity to justify a specification which was adopted by the A. S. T. M. in the year 1914 as serial designation A-16-14.

In respect to the variability of the product, the average elongation of the 1913 product from five mills for the plain and deformed bars varied from 16.4 to 17.7 per cent, and the tensile strength varied from 101,420 to 101,650 lbs. per sq. in.

No Advantage in Twisted Bars

Considering the variability of individual bars from the averages the report of the investigation referred to showed a typical variability curve. Applying the standard specifications to the product resulting from these mills, it was found only 1 per cent of the bars ¾ in. diameter and below would not pass the specification for ductility, 2 per cent for bars 1 in. and below, and approximately 2½ per cent for all sizes. The twisted square bars are not of as good quality as other shapes. In fact there appears to be little advantage in using the twisted square bar in any class of metal.

The nature of rail steel bars as disclosed by the only thorough examination of the product that has been made is thus of a high quality of hard grade carbon steel bar, having appropriate strength and ductility for this class of material.

It should not be punished as severely as softer and weaker steels. In fact, it is understood that in the early days of reinforced concrete one company used this high carbon rail steel to roll deformed bars containing heavy projections closely spaced, and experienced difficulties in handling.

With the present designs of deformed bars, this difficulty in the use does not appear to be substantial.

Since the year 1913 this material has been widely used in increasing amounts. The practice of the rolling mills has been more carefully controlled, especially to avoid sudden cooling of the bars. No doubt a similar survey of the mills at the present day would show an equal if not better product.

These reinforcing bars come from the web, head or flange of the rail. The rail is heated in a furnace, split into the three parts just mentioned, then rolled into various products. Probably one million tons are produced by a score of mills. The rail steel reinforcing bar is only one of the commodities produced. There are probably 250,000 to 500,000 tons of concrete reinforcing bars marketed each year, and used in concrete structures such as buildings, bridges, reservoirs, foundations, etc.

Rails Sorted at Mill

Naturally the rails which form the basic material of this industry come to the rolling mills after having been in the track for various periods of time. Various classes of rails are received, of several sizes and carbon contents. As a practical matter of operating the mills, these rails must be sorted out into their respective classes, so that the bars coming through the mill in one shipment may be expected to be uniform in quality. It has been found also that the process of re-heating and rolling these rails into smaller sizes increases the ductility.

For instance, in the case of the 75-lb. rail of .24 carbon, the product of the tensile strength and elongation was 1,370,000 in the original rail and of the rerolled material 1,890,000. Elongation had increased from 14.8 per cent to 20.1 per cent. Ductility is the result not only of chemical composition, but also of rolling conditions. By improved rolling mill practices, strength due to high carbon can be obtained without loss of necessary ductility.

Reinforcing bars in general should be judged on the basis of their use. Concrete is essentially a monolithic construction and one unit in the construction is held together by a plurality of bars which are protected from direct shocks. The engineer, therefore, does not need that each individual bar should be identical with every other. He does not expect that this will be so in an all-steel structure. Reinforcing bars as a class may be as uniform as the component parts that go to make up a riveted steel column, and much more uniform than the concrete that they reinforce.

What Joint Committee Says

Since 1913 the Joint Committee on Concrete and Reinforced Concrete of the several engineering societies has had under consideration the specifications for reinforcing bars with the result that they have included rail steel in their specifications on the same basis of strength as other classes of bars.

Since the 1913 A. S. T. M. tests only one set of tests of any extent has appeared. The Bureau of Standards selected rail steel bars from five different warehouses and new billet bars from five different mills under the specifications that these latter be hard grade bars. These new billet bars turned out to be of a softer grade. In all there were about 1400 bars tested in tension.

With the exception of one lot of rail steel bars, all met the specifications for strength. All of the bars of both classes except the ¾-in. bars of one lot of rail steel and one lot of billet steel met the specification for cold bend. The bars were also tested under the hammer in impact, and none of them broke under the impact test. As a result of this the report of the Secretary of Commerce of 1922 stated that this rail steel was satisfactory material for reinforcing concrete.

There have been also minor reports of tests, but none approaching the extent of the Bureau of Standards.

Highway Research Board

The fifth annual meeting of the Highway Research Board of the National Research Council will be held at Washington, D. C., December 3 and 4, 1925. Progress reports received from the chairman of the research committees showed that they are conducting important studies on almost every phase of highway development, including finance, design, construction and maintenance, thus assuring a successful annual meeting. The program for the fifth annual meeting is now being prepared and will soon be announced.

Dressing Up a Street in Greeley, Colo.

By WILLIS H. PARKER

Producers of ornamental concrete can take a suggestion from this story. Civic pride is worth appealing to. To sell a thing sometimes, it is only necessary to ***start*** selling it. The idea grows.

The Greeley Concrete Works, D. M. Ferris, proprietor, joined in a street decoration scheme in Greeley, Colo., that gave the firm some additional business as well as a lot of good advertising.

A visitor to Greeley is struck with the hundreds of flower boxes along the curbs in the business district. In front of almost every store is a concrete standard, about 30 in. high, topped with a wooden tub of flowers. Uniform standards, uniform flower containers, uniform flower designs, all set at uniform distance from the curbing—about 6 in.—certainly help to make the business district of the town pretty. The idea was conceived by a druggist who presented the matter to the Chamber of Commerce, where it was adopted, and the Garden Club enlisted as an aid to putting the plan over.

All of the merchants were solicited by committees to subscribe to the work and a triple alliance was formed between the concrete works, the Greeley florists and the Garden Club wherein the concrete works furnished the standards for a dollar each. The Garden Club furnished the wooden tubs at the same price and the florists filled them for a dollar—making the total initial cost to the merchants three dollars each. So in the spring of 1925, the concrete plant was busy making the 300 standards to supply the orders. The standard consists only of a concrete tile about 10 in. in diameter set upon and cemented to a square slab of concrete 3 in. thick and about a foot square. Any concrete man knows how to make them, but all will admit that a dollar each for them is scarcely more than the cost of manufacture. But think of the advertising value of having 300 of your flower pot standards scattered over the entire business district of a city of about 15,000 people. Don't you suppose many home owners will see them and desire similar concrete articles for their lawns and flower gardens?

Concrete standards with flower boxes decorate the streets in the Greeley business district

Any concrete man can well afford to join in such a scheme of city beautification at cost for the work—not only because he is helping beautify the community but because of the advertising his work placed about the business section of the town will give him.

A. R. B. A. To Tie Up Show To "Good Roads Week"

The American Road Builders' Association, which was organized more than twenty years ago and ever since has been conspicuously identified with the great movement for more and better roads, is planning another forward step.

In the past, the annual meetings of the Association have been planned especially for those actively engaged in the various phases of highway construction. Contractors, engineers, government, state, county and city officials have flocked to Chicago in January in order to attend the sessions of the American Road Builders' Association Convention and visit the great Road Show which has been held in the Coliseum and which in the last two or three years has overflowed into a number of adjoining buildings.

Beginning next January, the Association is planning to tie up its annual meeting with a "Good Roads Week" to be observed throughout the country. The week of January 11, 1926, has been selected as the first "Good Roads Week" and at that time exercises will be held in the public schools, and civic clubs also will hold special meetings.

At the same time the Annual Convention of the American Road Builders' Association will be in progress in Chicago. Men interested in road building from all over the country will be in attendance. The Coliseum and neighboring buildings will be filled with more than three hundred carloads of road machinery and materials.

Last January more than 16,000 persons attended the Convention and Show, and it is expected that the throng will be even greater in 1926.

W. H. Connell, President of the American Road Builders' Association and Engineering Executive of the Pennsylvania Department of Highways, has announced that the Convention program in Chicago next January will be divided into two sections, the first section which will be of special interest to contractors dealing with the actual construction of roads, and the second section which will appeal to the engineers and municipal officials dealing with the technical problems of highway work.

As usual reduced railroad rates to Chicago will be in effect the week of the Convention and Road Show of the Association.

C. M. Upham is Business Director of the Association. Any requests for preliminary information should be addressed to him in care of the American Road Builders' Association at Raleigh, North Carolina.

A proposed change in the intermediate point rule covering rates on cement in Western trunk line territory has been found not justified by the Interstate Commerce Commission. The item previously had been suspended by the Commission upon protest filed by the Iola Cement mills traffic association and finally was cancelled July 29. The effect of the proposed rule would have been to make rates to points in southeast Missouri higher than rates to points in southern Illinois. The Iola Association for some time has been endeavoring to have the rates to southeast Missouri adjusted. Rates from those points are in some instances shown to be higher than combination of local rates through such junction points as Pittsburg, Kansas, and Springfield, Missouri, and higher than scale III cement rates.

Making Concrete Light Posts for St. Louis

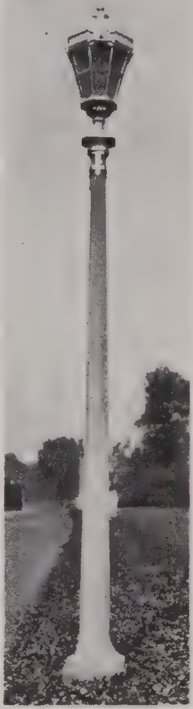


Fig. 1—St. Louis' New Lighting Standard

Under a bond issue voted in 1923, the city of St. Louis, Mo., is replacing its old gas street lights with an up-to-date electric lighting system. After many tests in which an artistic and durable light standard was sought, the city selected a design which called for concrete construction, and is now manufacturing these poles at its own plant.

The new standards are being installed wherever new streets are being opened. A total of $8,000,000 is to be expended in the next few years on the new lighting plan.

Crushed red granite to 3/8 in. size and fines limited to 30% portland cement and water, in a one-four mixture, are used in making the poles. The first step in the manufacture is the preparation of wooden molds. Into each of these is fitted a cage of reinforcing, using 3/8-in. bars. In the center is a two-inch galvanized tin tube, through which is passed electric wiring.

After the concrete has been poured, it is permitted to harden for about 24 hours. The form is then removed and the pole is covered with wet sacks if the weather is warm. The surfaces are later gone over with rasps and then scrubbed thoroughly with a 50% solution of muriatic acid. After two applications of the acid and after a rubbing with a carborundum stone and wire brushes, the pole is washed off with a hose and left to dry to gain further strength. The scrubbing develops a very interesting color and texture.

J. W. Brooks, in charge of the plant, explained that with a crew of 20 men, he turned out 100 poles a week.

The post is finished and ready to be taken from the yards in about fourteen days. The completed post weighs 1,200 pounds and is 17 feet, 5 in. high with a base 18 in. square. It tapers 4½ in. at the top. The four corners are beveled. The base is placed 52 inches in the ground, being set in a hole like telegraph poles. An aluminum top is fitted over the standard to hold the lamp.

The city began experimenting with concrete light posts in 1920. In that year 3,000 posts were made and placed along various streets. Then until 1924 no further work was undertaken, when the new bond issue money became available. A number of improvements have been made over the old standards. Chief among these was in placing a larger tube inside the concrete posts for the electric wiring. The old tubing was of iron and was much smaller, requiring the services of two extra men to strip and draw the wires through. It is estimated the galvanized tin of larger dimensions as now used will save many thousands of dollars by the time the street lighting program is completed.

Another improvement is the substitution of an aluminum cap weighing 11 pounds for the old iron cap, weighing 34 pounds, as used on the first posts.

Automobilists frequently bump into the standards and chip them off or even break them in two, according to G. B. Heath, general superintenent of cost and maintenance, but the city forces the driver to pay for a new post if the damage is great. In case of minor chips, a patch is usually put on, but as these do not look well, a new post is set wherever needed.

Ralph Toensfeldt, engineer, is in charge of the street lighting program and is constantly watching the designs and appearance of the standards with a view to improvement.

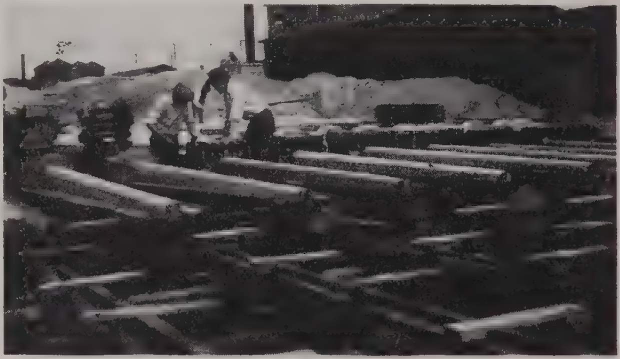


Fig. 2—Stripping the Forms.
Fig. 3—Finishing the Surface.

Cold Storage Plant of Unusual Construction

The largest cold storage plant on the Pacific Coast is being built in the industrial section of Los Angeles for the Federal Cold Storage Co. There are a number of unusual features used in the construction of this building.

The building is 200 feet square, six stories and basement, located alongside of the present ice plant belonging to the Federal Cold Storage Co. The work is being done by the Scofield Engineering-Construction Co. of Los Angeles, who sub-let the slip-form outer walls to the Kimmerele-Hess Co. of Los Angeles.

Ground was broken on June 1 by the general contractors, and the sub-contractors began pouring the outer walls on July 20 and finished August 8, consuming 19 days in the pouring of the entire wall, using the slip-form method and pouring continuously twenty-four hours a day. This continuous pouring left no construction joints in the walls.

The general contractors are pouring one floor a week and expect to finish the entire building on November 1, six months from the time of breaking ground.

The outer walls are double, 18 in. thick on the inside and 12 in. thick on the outside, with a 12 in. air space to be filled with granulated cork. The forms of these walls were moved up an average of 5 ft. in twenty-four hours. At the floor lines a recess of 6 in. x 9 in. was left in the walls and stubs of rods for connecting to the floor system were turned down in these boxes until the wall forms had passed the floor lines, whereupon the boxes were removed and the stubs straightened out ready for the pouring of the floors.

The floors are flat slab construction 9 in. thick with integral finish and are being poured in four sections.

An interesting feature of this building is the fact that the cork insulation is laid upon the forms and the floor concrete poured over the cork. The columns are likewise lined with cork before they are poured.

The building has four elevators and no openings above the ground floor except for the passage of ammonia pipes. The building contains 3,500,000 cu. ft. of storage space and will be used to preserve produce when there is a glut in the market.

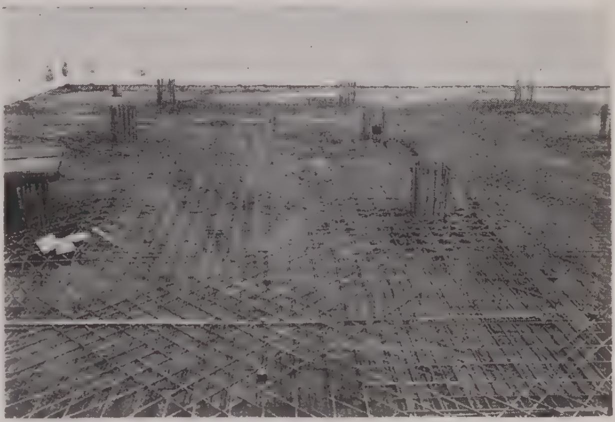


Fig. 4. The reinforcing for the concrete floors is laid over the cork.

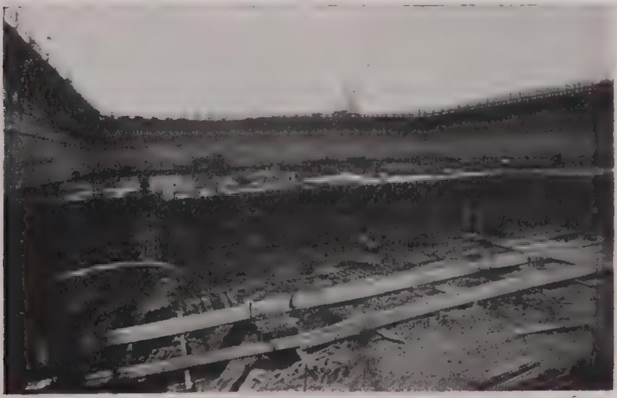


Fig. 2. The board forms for the concrete floor. The cork is laid directly on forms, then the steel reinforcing, and over this poured the 9-in. concrete floor.

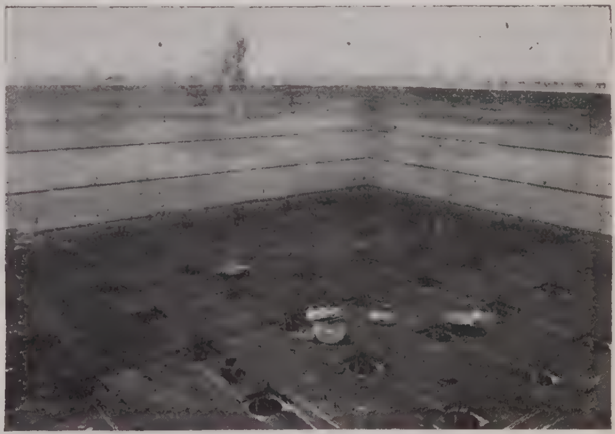


Fig. 3. The cork sub-base of the concrete floors is laid on the board forms.

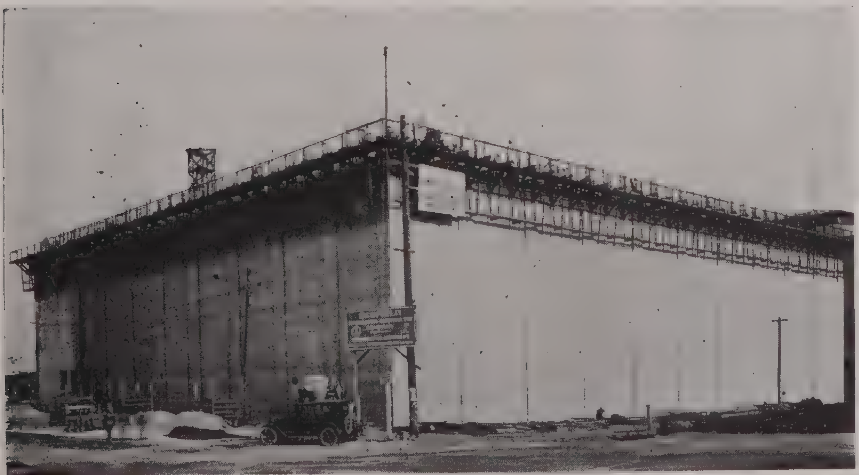


Fig. 1. The outer walls of the Federal Refrigerating Plant. The wall forms were moved up 5 ft. each day and the pouring was continuous.

Cold storage plants are in great demand. New construction methods are of real importance whenever developed and are always welcomed.

"Effect of End Condition of Cylinder on Compressive Strength of Concrete"

Abstract of Bulletin 14, Structural Materials Research Laboratory

By HARRISON F. GONNERMAN

Data of value to testing engineers and others interested in concrete tests have just been published in Bulletin 14 of the Structural Materials Research Laboratory, Lewis Institute, Chicago, "Effect of End Condition of Cylinder on Compressive Strength of Concrete," by Harrison F. Gonnerman. The report is reprinted from the 1924 proceedings of the American Society for Testing Materials.

Experience has shown that it is not always practicable to obtain perfect workmanship in the making of test cylinders. A common defect in test cylinders made in the field is uneven end surfaces. These tests were made for the purpose of determining the effect of uneven and irregular ends and to study the effect of different methods of treating the ends in applying a compressive load. Other factors such as the use of spherical bearing blocks, the inclination of axis of specimen, and the deflection of the bed of the testing machine were also studied. About 3000 6x12-in. concrete cylinders of 1:7, 1:5, 1:3½ and 1:2 mix by volume were tested at ages of seven days to one year.

The relative effect of the different end conditions was judged principally by the ratio of the strength obtained for a given condition to that obtained for a standard method specified in the "Tentative Methods of Making Compression Tests of Concrete" (Serial Designation C39-21T), of the American Society for Testing Materials. This method requires that the cylinder be molded on a plane machined cast-iron base plate and that the top be capped when made by means of a machined cover plate and neat cement which has been mixed and allowed to stand two to six hours before use. Test to be made with a spherical bearing block on top of the cylinder.

The principal conclusions from the tests were:

The standard method of molding and capping concrete cylinders with machined base and cover plates gave uniformly high strength, equal to or greater than that from any of the other methods.

For reliable results the use of an adjustable block with spherical bearing surfaces was found to be essential.

Small errors (¼ in. or less) in centering the bearing block on the cylinder had little or no effect on concrete strength. An error of ½ in. in setting, gave strength-ratios of about 90% for 1:5 and 1:3½ concrete.

Smooth trowelled tops (cylinders molded on machined base plates) gave the following results:

With thin caps of gypsum or mixtures of cement and gypsum, the results were essentially the same as those obtained for the standard method of capping.

Without bedding, the strength-ratios obtained were about 95% for 1:7 concrete, 94% for 1:5 concrete and 80% for 1:3½ concrete.

With sheet materials between top of cylinder and the spherical block, the strength-ratios obtained were less than 100% for all of the materials used.

For the sheet materials, the best results were obtained with beaver board, which gave strength-ratios of about 100% for 1:7 and 1:5 concrete and about 90% for 1:3½.

For white-pine board, mill board and leather, the strength-ratios ranged between those found for beaver board and those found for no bedding.

For the other sheet material, blotting paper, sheet lead and rubber, the strength-ratios were less than those found for no bedding.

The lowest strength-ratios were found for the 1/16-in. sheet rubber—about 80% for 1:7, 70% for 1:5 and 50% for 1:3½ concrete.

Cylinders made and capped by the standard method, tested with a ½-in. segment (circular segment of ½-in. mid-ordinate) of the cap removed, gave strength-ratios slightly less than 100 per cent. When a 1-in. segment was removed the strength-ratios obtained were 100 per cent for 1:7 concrete, about 95 per cent for 1:5 concrete and 90 per cent for 1:3½ concrete. The removal of a 2-in. segment gave strength-ratios of 90, 80 and 65 per cent for the three concretes. When the segments removed were replaced with 1:1 gypsum and cement mortar three hours before test, the strength-ratios were about 100 per cent except for the 2-in. segment, which showed strength-ratios of from 95 to 90 per cent.

Cylinders with plane parallel ends but with axes inclined, gave the same strength as standard cylinders for an inclination of ¼-in. in 12-in. and strength-ratios of about 92 per cent for an inclination of ½-in. in 12-in.

Cylinders with top surface inclined showed strength-ratios of about 100 per cent for an inclination of ¼-in. in 6-in. and of about 95 per cent for an inclination of ½-in. in 6-in.

Cylinders molded with machined cast-iron plates so as to give convex ends and tested without bedding, gave pronounced reductions in strength even for a small convexity. The strength-ratios were smaller the greater the convexity and the richer the mix. For a convexity of 0.01-in., the 1:3½ and 1:2 mixes showed strength-ratios of about 65 per cent and for a convexity of 0.05-in. about 40 per cent. For the 1:7 and 1:5 mixes the corresponding strength-ratios were about 80 and 55 per cent. When tested with beaver board sheets top and bottom the reductions in strength were about half as great as without bedding. The use of gypsum bedding for one group of cylinders with bases convex 0.05-in. gave strength-ratios of about 90 per cent.

The effect of concave ends was small compared to that of convex ends.

Sheared steel plates 8 in. square by ¼-in. thick from warehouse stock showed deviations from a true plane of as much as 0.012 in. Cylinders molded with these plates as bases and covers so as to give convex ends, gave results comparable with those from cylinders having the same convexity, similarly made with machined cast-iron plates.

Finally, the most important conclusion from these tests is that great care must be exercised when preparing concrete cylinders for test in order to secure plane ends. When the standard method of capping with plane cover plates cannot be followed, the cylinder should be trowelled smooth and capped with a thin layer of gypsum, or a mixture of gypsum and cement, three to six hours before test. The cylinders may be conveniently capped by placing a small amount of the capping material on a plane metal or glass surface and pressing the end of the cylinder down upon it, taking care to keep the cylinder in a vertical position during the operation. The cylinders should always be molded on a plane surface; in testing field cylinders which have not been so molded it is recommended that the ends be capped with a thin layer of neat cement two or three days before test, following the method described above for trowelled tops. The standards and tentative standards of the American Society for Testing Materials require that the cylinders be tested in a damp condition.

Further Uses of Alumina Cement

At the recent annual meeting in London of the Francois Cementation Co., Ltd., the British organization exploiting the French aluminous "ciment fondu," Harry Clayton, the president, made some interesting statements regarding important contract work the concern had received.

Since the commencement of 1925 it has secured a contract for the sinking of two shafts for the Bolsover Colliery, a large modern colliery at Thoresby, in Lincolnshire, England, and nine other smaller contracts. It has also obtained a contract for the sealing off of leakages at the Nundydroog mines, in the Kolar goldfields, India. At Rosehall, Scotland, it has satisfactorily driven sheet piling through 70 feet of running quicksand.

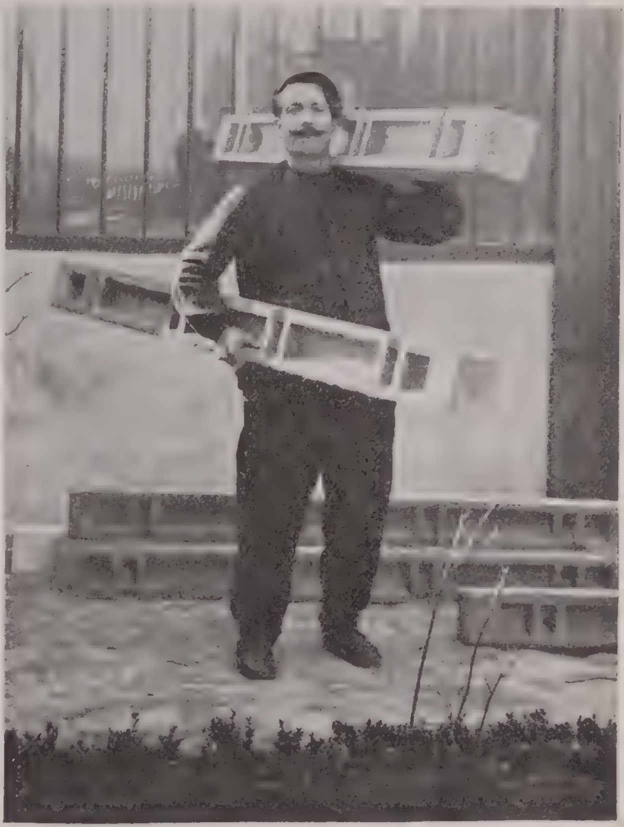
The recent world-wide discussions regarding the unsafe condition of Britain's most famous cathedral, St. Paul's, were also mentioned by Mr. Clayton. The committee of engineering experts advisory to the cathedral authorities reported favorably on the concern's experimental work in consolidating the piers. As a result of this experiment a program of work has been adopted and the cathedral authorities have decided to utilize the Francois company's services to increase the strength of all the piers by cementation as a precautionary measure.

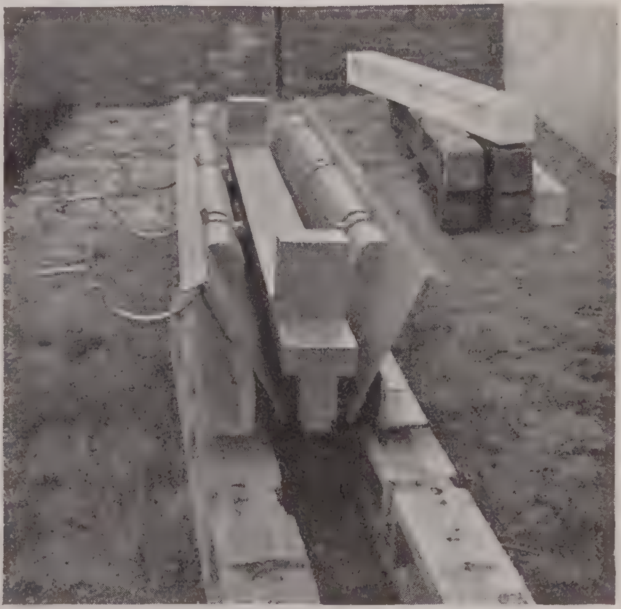
The application of the Francois process for the consolidation of reservoir foundations to render them impermeable to the passage of water has been extended. The cementation of the foundations of a reservoir at Birmingham has just been completed and work is at present being proceeded with on the cementation of the foundations of the reservoirs of the cities of Barnsley and Bateley, England.

An interesting contract was entered into with the corporation of Burnley for the sealing of six leakages from Hurstwood reservoir. Work on this contract is still in progress. Before the commencement of treatment the leakages as recorded by one gauge alone amounted to 1,000,000 gallons per day, irrespective of any other unmeasured leakages. To date this leakage of 1,000,000 gallons per day has been completely sealed off—a reduction of 100 per cent. The reservoir, however, is still leaking to the extent of 30,000 gallons per day from other points, and the treatment of this is proceeding with every probability of complete success.

Long, Light Concrete Masonry Units

The illustrations show a new concrete masonry unit being used in France, and the mold in which it is cast. It is pointed out that it simplifies construction to a large degree. Each element is about four feet long, yet light enough to be handled by one man. The result is that instead of the labor involved in laying perhaps four or five shorter blocks, the work is lessened considerably by only having to lay one long one. As factories are being put up at present in France at a rapid rate, and as the French have found that concrete is one of the best building materials for such structures, a good future is predicted for this unit. CONCRETE's correspondent says the blocks pictured, although light, will stand a very heavy strain, and have not the tendency to crumble that most of the concrete tiles molded "on the premises" have so far shown. The manufacturer of the molds (or of blocks on order) is M. Lobour, 156 ter, rue Magenta, Paris.





The upper picture shows two of the new units ready for use, while the lower shows molds in place

Bringing in the Sand

Here is how the contractor gets his lake sand in the region of the Great Lakes. Fleets of boats, such as this one, make frequent visits to portions of the lake where good sand can be had for the dredging, suck up a load for their holds, and bring this material to the market. Conveyors installed on the boat take care of the unloading when the dock is reached. This method of securing clean, well graded, sand is coming more and more into favor, and some really big craft are engaged in this branch of the sand industry.

Will Build and Destroy Concrete Dam to Learn Arch Design

More than $70,000 has been raised by a special committee of the Engineering Foundation, which, to settle science problems centuries old, will erect and destroy an arch dam 100 ft. high on Stevenson Creek a tributary of the San Joaquin River, about 60 miles east of Fresno, Cal., says an announcement of the "Engineering Foundation."

Engineers of America and Europe are aiding the plan, which is attracting world interest among engineers. "Testing to destruction" an actual structure, it was said, is new to engineering effort. About $100,000 will be spent to determine by this method the principles of concrete arch design.

The arch dam investigation is being made by members of the American Society of Civil Engineers in co-operation with the U. S. Bureau of Reclamation, the states of California and Oregon, the city of San Francisco, Los Angeles county, power companies, irrigation districts, universities and individual engineers.

During the summer the foundation for the dam is being prepared and other initial steps taken in construction work. A large number of special instruments for measuring stresses, taking temperatures and observing the slight movements of the dam during its construction and testing will be made. These instruments will be carefully tested at the Bureau of Standards of the Department of Commerce in Washington before being put into the dam.

"Many factors combine to make this unusual experiment possible," said a statement issued at the headquarters of the Engineering Foundation in New York. "The natural conditions at the dam site are remarkably favorable.

"Proximity to the main water supply conduit of the Southern California Edison Company assures an ample supply under complete control. Moreover, the quantity of water needed and the consequent danger from failure of the dam as it is tested are minimized by the peculiar ruggedness of the site.

"The dam itself will be of striking dimensions. The abutments are to be excavated to solid rock foundation, giving the elevation in general 90-degree V shape. At its lowest point the dam is to be 7 ft. 5 in. thick, gradually tapering to 2 ft. at the 30-ft. level above which it retains this thickness.

"It is purposed to build first to a 60-ft. height and after making complete tests to extend the dam, 2 ft. in thickness, 40 ft. farther in 10-ft. lifts to a total elevation of 100 ft. The upstream radius of curvature of the arch will be uniform, 100 ft.

"In size the structure will actually exceed some existing arch dams, so that the results of testing will have immediate practical utility. The local advantages will promote ease and speed of a great variety of observation. Not the least among the conditions favorable to the project are the character of engineering talent in charge of the tests and the extensive financial support of public utility corporations, construction companies, manufacturers and engineers.

The placing of concrete masonry is expected to begin in October. When the dam has been built to a height of 60 ft. it will be subjected to tests and observations about one year. It is then planned to increase its height in 10-ft. steps to a total of 100 ft. At each stage the testing will be continued.

"The dam is to be situated in a rough, rocky gorge in the mountains where no damage could result if the dam should break under the tests. An important water supply conduit of the Southern California Edison Company, just above, will afford the use of water as needed for the tests without dependence upon local rainfall or melting snow."

The tests, it is said, will be useful in designing and building other concrete structures, particularly other types of dams and arches for other purposes.

Table of Aggregates Revised

The table of aggregate proportions and batches adopted as standard for mixers by the Associated General Contractors and the mixer manufacturers has been revised to accommodate the new rating given the 21-E mixer. The revised table follows:

MAXIMUM CAPACITY OF STANDARD MACHINES IN FULL BAGS PER BATCH

	Building mixers						Paving mixers		
Mix proportions	3½-S	5-S	7-S	14-S	21-S	28-S	7-E	13-E	21-E
1-1½-3	1	1	2	4	6	8	2	3	7
1-1½-3½	½	1	1	3	5	7	2	3	6
1-1¾-3½	½	1	1	3	5	7	2	3	6
1-2-3	½	1	1	3	5	7	2	3	6
1-2-3½	½	1	1	3	5	7	1	3	6
1-2-4	½	1	1	3	4	6	1	3	5
1-2½-4	½	1	1	3	4	6	1	2	5
1-2-5	½	½	1	3	4	6	1	2	4
1-2½-5	½	½	1	2	4	5	1	2	4
1-3-5	½	½	1	2	3	5	1	2	4
1-3-6	½	½	1	2	3	4	1	2	3

RESULTANT CONCRETE OF FULL SACK BATCHES ABOVE

	Building mixers						Paving mixers		
Mix proportions	3½-S	5-S	7-S	14-S	21-S	28-S	7-E	13-E	21-E
1-1½-3	3.55	3.55	7.10	14.20	21.30	28.40	7.10	10.65	24.85
1-1½-3½	1.93	3.86	3.86	11.58	19.30	27.02	7.72	11.58	23.16
1-1¾-3½	2.03	4.05	4.05	12.15	20.25	28.35	8.10	12.15	24.30
1-2-3	1.95	3.89	3.89	11.67	19.45	27.23	7.78	11.67	23.34
1-2-3½	2.10	4.20	4.20	12.60	21.00	29.40	4.20	12.60	25.20
1-2-4	2.26	4.52	4.52	13.56	18.08	27.12	4.52	13.56	22.60
1-2½-4	2.43	4.85	4.85	14.55	19.40	29.10	4.85	9.70	24.25
1-2-5	2.57	2.57	5.13	15.38	20.52	30.78	5.13	10.26	20.52
1-2½-5	2.74	2.74	5.47	10.94	21.88	27.35	5.47	10.94	21.88
1-3-5	2.92	2.92	5.83	11.66	17.49	29.15	5.83	11.66	23.32
1-3-6	3.25	3.25	6.50	13.00	19.50	26.00	6.50	13.00	19.50

Fine Grinding of Cement Increases Strength of Concrete

By **MORRIS TEMIN** and **W. H. SLIGH**
Bureau of Standards

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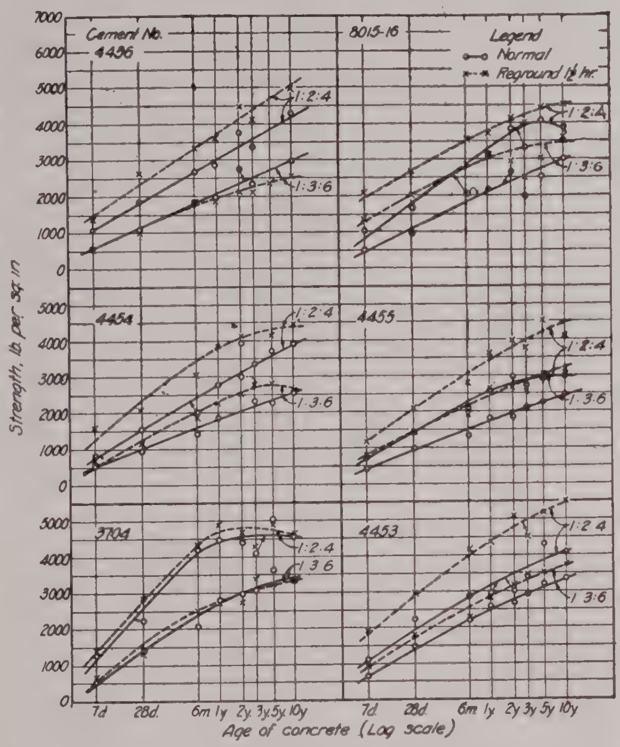
This paper deals with an investigation of (1) the effect of fine grinding of cement on the strength in concrete, and (2) the changes in strength of the test specimens during a period of ten years. Other investigations on the effect of fine grinding on strength have been reported since this work was undertaken, but most of these tests were limited to a short period of time, usually one year.

Figure A.—Showing the relative increase in compressive strength of concrete made from reground and normal cement with age



From this investigation the following relations may be studied:

1. Effect of fineness of cement on the strength of concrete.
2. Relative effect of fineness of cement on the strength of 1:2:4 and 1:3:6 (by volume) concrete.
3. Comparison of the effect of fineness of five different brands of cement on the strength of concrete.
4. Effectiveness of fine grinding of cement in retaining its strength over the period of ten years.
5. Effect of age on the strength of concrete over a period of ten years.

For this investigation five commercial brands of cement were used. These cements were received direct from the manufacturers and represented their marketable product. Each cement as it was received was mixed and divided into two lots; one lot was stored in air-tight containers and the other lot was ground one and one-half hours in a ball mill at the Bureau.

For the purpose of identification of the cements used in this investigation they will be given numbers corresponding to the laboratory numbers given them as they were received: 3704, 4453, 4454, 4455, 4456, 8015 and 8016. Cements 3704, 8015 and 8016 are from the same manufacturer. No. 3704 is the product as sold on the open market, 8015 was taken from the belt conveyor and 8016 was taken from the dust collector. The variation in fineness between No. 8015 and No. 8016 is 20.1 per cent on a No. 200 mesh sieve and represents the extreme variation in the investigation.

In order to obtain data as to the effect of fine grinding on cement made by different processes of manufacture and by different methods of grinding, materials made by both the wet and dry process were selected and ground in the following kinds of mills: Fuller-Lehigh, Tube, Roll and Griffin.

TABLE 1.—TESTS OF PORTLAND CEMENT CHEMICAL ANALYSES

Lab. No.	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	SO_3	Loss	Insol.
3704	22.28	2.90	6.60	61.30	2.32	1.75	1.83	.28
4453	23.48	2.25	4.81	62.80	2.12	1.40	1.44	.50
4454	19.60	2.60	8.00	62.20	1.40	1.42	3.62	.16
4455	20.38	2.75	7.51	62.00	2.12	1.62	1.80	.12
4456	21.96	1.60	7.60	62.00	3.20	1.36	1.19	.26
8015	22.54	2.75	7.21	62.00	2.44	1.28	1.09	.27
8016	21.66	2.70	6.62	62.30	2.50	1.72	2.48	.10

Cement—Table 1 gives the chemical analyses of the cements. The physical tests are shown in Tables 2, 3 and 4. The time of setting is shown in Table 2. As is generally observed, fine grinding reduced the time of setting. For soundness tests three pats were made. Twenty-four hours after making one pat was placed for five hours in steam, one was placed in air and the other placed in water. The

TABLE 3.—RESULTS OF TESTS OF NEAT AND MORTAR SPECIMENS

		Neat Cement			1:3 Standard Sand Mortar Tests					
		Tensile Strength (lb./in.²)			Tensile Strength (lb./in.²)			Comp. Strength (lb./in.²)		
Lab No. Cement	Treatment of Cement	% Water	7 da.	28 da.	% Water	7 da.	28 da.	% Water	7 da.	28 da.
3704	Normal	21.2	642	751	10.0	234	453	10.0	1706	3402
3704A	Ground 1½ hours	21.8	580	827	10.2	313	513	10.2	1770	3977
4453	Normal	25.0	707	728	10.7	275	381	10.7	1912	2907
4453A	Ground 1½ hours	24.0	773	735	10.5	380	520	10.5	3223	3780
4454	Normal	24.0	600	650	10.5	218	340	10.5	1645	2551
4454A	Ground 1½ hours	24.0	773	792	10.5	303	372	10.5	2913	3623
4455	Normal	22.5	608	619	10.2	282	391	10.2	1790	2717
4455A	Ground 1½ hours	23.0	712	682	10.3	361	462	10.3	2808	4434
4456	Normal	23.0	709	763	10.3	283	413	10.3	1833	3457
4456A	Ground 1½ hours	23.5	717	644	10.4	287	476	10.4	2270	2737
8015	From belt	22.0	701	764	10.0	248	362	10.0	1411	3143
8016	From dust collector	30.0	473	505	11.0	387	495	11.0	2677	5242

Each value is the average of three or more tests.

air and water pats were examined at 7 and 28 days. All pats were satisfactory for soundness.

Table 3 shows the strength of neat briquettes, 1:3 Standard Ottawa sand briquettes and 1:3 Standard Ottawa sand 2-inch cubes.

Table 4 gives the fineness analyses of the cements. The analyses show a complete determination of the size gradation of the cements used in the investigation. This size gradation was determined by means of the air analyzer and the No. 100 and No. 200 sieves. A full description of the air analyzer is published in Bureau of Standards Technologic Paper No. 48.

TABLE 2.—PHYSICAL TESTS OF PORTLAND CEMENT

Lab No.	Time of Setting: Initial Hr.	Initial Min.	Final Hr.	Final Min.	Soundness Air, Water, and Steam
3704	5	29	9	14	All O. K.
3704A	5	10	7	20	
4453	5	47	7	42	
4453A	5	14	7	09	
4454	5	08	7	43	
4454A	4	40	7	00	
4455	6	45	9	45	
4455A	6	31	9	11	
4456	5	17	7	02	
4456A	4	52	6	52	
8015	1	40	5	25	
8016	1	05	4	50	

TABLE 4.—MECHANICAL ANALYSES OF SAMPLES OF CEMENT

Number	Condition	Size Gradation in m.m.: Air Analyzer, Per cent blown off 0.02	0.04	0.06	Sieves, Per cent Passing 0.11*	0.20*
3704	Normal	30.9	51.1	59.8	79.2	95.5
3704A	Ground 1½ hours	37.9	58.7	67.6	88.2	99.6
4453	Normal	27.0	51.5	62.2	80.8	96.6
4453A	Ground 1½ hours	38.5	65.1	76.9	94.4	100.0
4454	Normal	30.7	49.7	58.3	79.4	97.0
4454A	Ground 1½ hours	39.4	60.0	69.3	89.9	99.7
4455	Normal	27.8	51.0	61.0	81.4	96.0
4455A	Ground 1½ hours	39.0	64.4	75.1	94.1	99.9
4456	Normal	25.7	45.7	55.2	75.2	94.1
4456A	Ground 1½ hours	36.1	58.9	68.9	90.3.	99.9
8015	Belt conveyor	30.9	50.4	58.2	79.0	95.5
8016	Dust collector	58.0	87.3	93.9	99.3	100.0

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*NOTE:—The 0.11 m.m. separation was made by means of the No. 200 sieve and the 0.20 m.m. separation by means of the No. 100 sieve.

Sizes of separations were determined by two dimensional microscopic measurements. Each separation indicates the maximum size of particles blown off by the air analyzer or passing through the sieve.

Concrete—The concrete cylinders were made at the laboratory in Washington of Potomac River sand and gravel. Table 5 gives the mechanical analyses of the sand and gravel. Two lots of material were used. Although they came from the same place, they vary somewhat in mechanical analysis. All specimens from Nos. 7304 through 4455A were made with the first lot of materials and the remainder of the specimens made with the second lot of materials.

The concrete cylinders were 16 inches in length and 8 inches in diameter. The cylinders were made in cast iron molds. These molds were machined top and bottom. The bottoms were placed on a steel plate when the cylinders were being molded. This insured a bearing surface perpendicular to the axis of the cylinder.

All concrete was mixed in a power-driven batch mixer. The materials were proportioned (either 1 part cement, 2 parts sand, 4 parts gravel; or 1 part cement, 3 parts sand, 6 parts gravel) by volume. The materials were weighed before being placed in the mixer. The water used was weighed and a uniform consistency was retained throughout the making of all the test pieces. The cylinders were made by filling the mold about one-fourth of the height at a time and tamping with a hand tamper, care being taken to give the tamper the same fall each time and systematically moving it over the entire surface. The molds were removed after 24 hours and the specimens were stored in moist air for 28 days. After 28 days the specimens were placed outside, exposed to Washington weather conditions until broken.

Figure B.—Showing the diminishing effect of the fine grinding of cement on the strength of concrete with age.

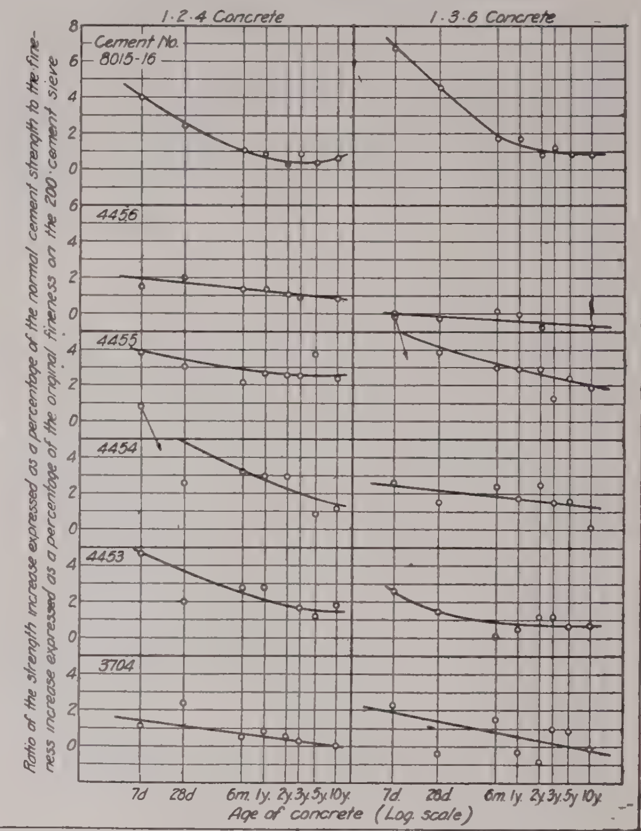


TABLE 5.—PHYSICAL PROPERTIES OF AGGREGATES—MECHANICAL ANALYSES

Material	Used with Cements Nos.	Per cent Passing Sieves Nos 4 .185 in.	8 .093 in.	14 .046 in.	28 .0232 in.	48 .0116 in.	100 .00584 in.
Potomac river sand	3704 to 4455A	98.8	88.1	75.6	53.5	22.8	7.2
Potomac river sand	4456 to 8016	99.2	88.4	77.3	53.4	17.2	3.3
		Screen with Opening 1½ in.	1 in.	¾ in.	½ in.	¼ in.	
Potomac river gravel	3704 to 4455A	100	78.5	56.5	26.5	.7	
Potomac river gravel	4455 to 8016	100	83.0	60.5	33.7	1.0	

TABLE 6.—STRENGTH OF CONCRETE CYLINDERS

(Cylinders 8 in. by 16 in. Mix by volume 1:2:4)

Cement Number	% Water	Age of Concrete 7 da.	28 da.	6 mo.	1 yr.	2 yr.	3 yr.	5 yr.	10 yr.
3704	7.15	1298	2260	4205	4500	4405	4085	5085	4566
3704A	7.0	1462	2855	4315	4915	4680	4225	4900	4591
4453	7.8	1098	2216	2868	2962	2990	3436	4300	4185
4453A	7.5	1946	2968	4150	4345	5100	4481	5185	5544
4454	8.2	832	1520	1980	2775	2978	3336	3692	3895
4454A	8.0	1585	2026	3057	3872	4120	3037	4100	4436
4455	7.7	749	1426	2092	2560	2850	2685	2865	2975
4455A	8.7	1197	2093	2777	3610	3960	3734	4540	4057
4456	8.7	1075	1862	2622	2820	3715	3362	——	4276
4456A	8.5	1395	2610	3323	3580	4445	4035	——	4969
8015	8.0	1020	1613	2805	3040	3800	3315	4020	3827
8016	8.3	2083	2630	3570	3670	4100	4000	4355	4448

Each value is the average of two or more tests.

TABLE 8.—STRENGTH—FINENESS INCREASE RATIO

Age	7 da.	28 da.	6 mo.	1 yr.	2 yr.	3 yr.	5 yr.	10 yr.
1:2:4 Concrete								
Ratio of increase in strength expressed as a per cent of normal to increase in fineness on a No. 200 sieve	4.6	3.0	2.4	2.3	2.4	1.2	1.4	1.4
Ratio of increase in strength expressed as a per cent of normal to the increase in fineness expressed as a per cent of the normal fineness on the No. 200 sieve	3.6	2.4	1.9	1.9	1.9	1.0	1.1	1.1
1:3:6 Concrete								
Ratio of increase in strength expressed as a per cent of normal to increase in fineness on a No. 200 sieve	4.2	2.2	1.8	1.4	1.1	1.6	1.6	0.6
Ratio of increase in strength expressed as a per cent of normal to the increase in fineness expressed as a per cent of the normal fineness on the No. 200 sieve	3.4	1.8	1.4	1.1	0.9	1.2	1.5	0.4

TABLE 7.—STRENGTH OF CONCRETE CYLINDERS

(Cylinders 8 in. by 16 in. Mix 1:3:6 by volume)

Cement	%	Age of Concrete							
Number	Water	7 da.	28 da.	6 mo.	1 yr.	2 yr.	3 yr.	5 yr.	10 yr.
3704	6.5	540	1384	2108	2809	3000	3080	3625	3356
3704A	6.8	679	1309	2460	2715	2720	3440	3240	3321
4453	7.5	660	1480	2200	2601	2640	2888	3185	3378
4453A	7.2	968	1841	2250	2835	3170	3490	3560	3783
4454	8.0	510	937	1402	1853	1889	2325	2267	2558
4454A	7.1	684	1125	1850	2293	2520	2770	2765	2598
4455	7.8	406	909	1346	1810	1828	2112	2205	2415
4455A	8.0	773	1450	1958	2640	2665	2536	3020	3148
4456	8.1	507	1053	1810	1940	2735	2300	——	2953
4456A	8.1	501	980	1850	1874	2120	——	2310	2504
8015	7.6	488	918	1984	2127	2605	1915	2505	3013
8016	7.4	1336	1979	2835	3073	2900	2526	3000	3642

Each value is the average of two or more tests.

The results of the strength tests are shown in Tables 6 and 7 and Figure A. Figure A shows a graph of the strength of the concrete against the age (log scale). There are four curves plotted. For the 1:2:4 mix, two curves are drawn, one for the normal cement and one for the one and one-half hour reground cement. For the 1:3:6 mix two curves are drawn, one for the normal and the other for the one and one-half hour reground cement. Figure B shows a graph of the ratio of the increase in strength, expressed as a percentage of the "normal" strength, to the increase in fineness expressed as a percentage of the "normal" fineness on the No. 200 sieve, against the age (log scale).

These curves are of interest, as they show that the effect of fine grinding decreased with the age of the concrete. The rate of decrease is not the same for all cements. Some of the cements show a uniform decrease, as 3704 and 4456 (Fig. B), but, in general, the curves show that the rate of decrease of the effect of fine grinding is decreased with age.

The curves in Figure B are also of interest in that they show that all cements are not affected by fine grinding to the same degree. In one case there appears a decrease in strength with increased grinding, but this difference between the results of 1:3:6 concretes of the 4456 and 4456A cement is very small and is probably due to experimental errors. This cement, however, does not show any increase in strength for the 1:3:6 concrete with the increased grinding.

The word "normal" is used to designate the cement as received. Attention is called to the ordinates of Figure B. The ordinates are the ratio of the increase in strength, expressed as a percentage of the "normal" strength, to the increase in fineness, expressed as percentage of the "normal" fineness on the No. 200 sieve. The customary method is to give only increase in strength, expressed as a percentage of normal divided by the increase in fineness of the No. 22 sieve. As the ordinates are presented here, consideration is given to the difference in fineness of the cement as received.

From the results of these tests the following conclusions may be drawn:

1. In general an increase in the fineness of the cement gave concretes of greater strength.
2. All cements do not give the same strength increase with the same fineness increase.
3. The effect of fineness on strength of concrete decreases with age.
4. A 1:2:4 (by volume) mixture shows a greater increase of strength with the same increase in fineness than a 1:3:6 mix (by volume).

An Early Concrete Dam That Still Stands

In 1881 William ("Concrete Billy") Dean, of Dean Woolen Company, at Newark, Del., undertook to build a dam of concrete construction. So far as present records go the work has fulfilled the purpose and remains as a monument to the enterprise of the builder.

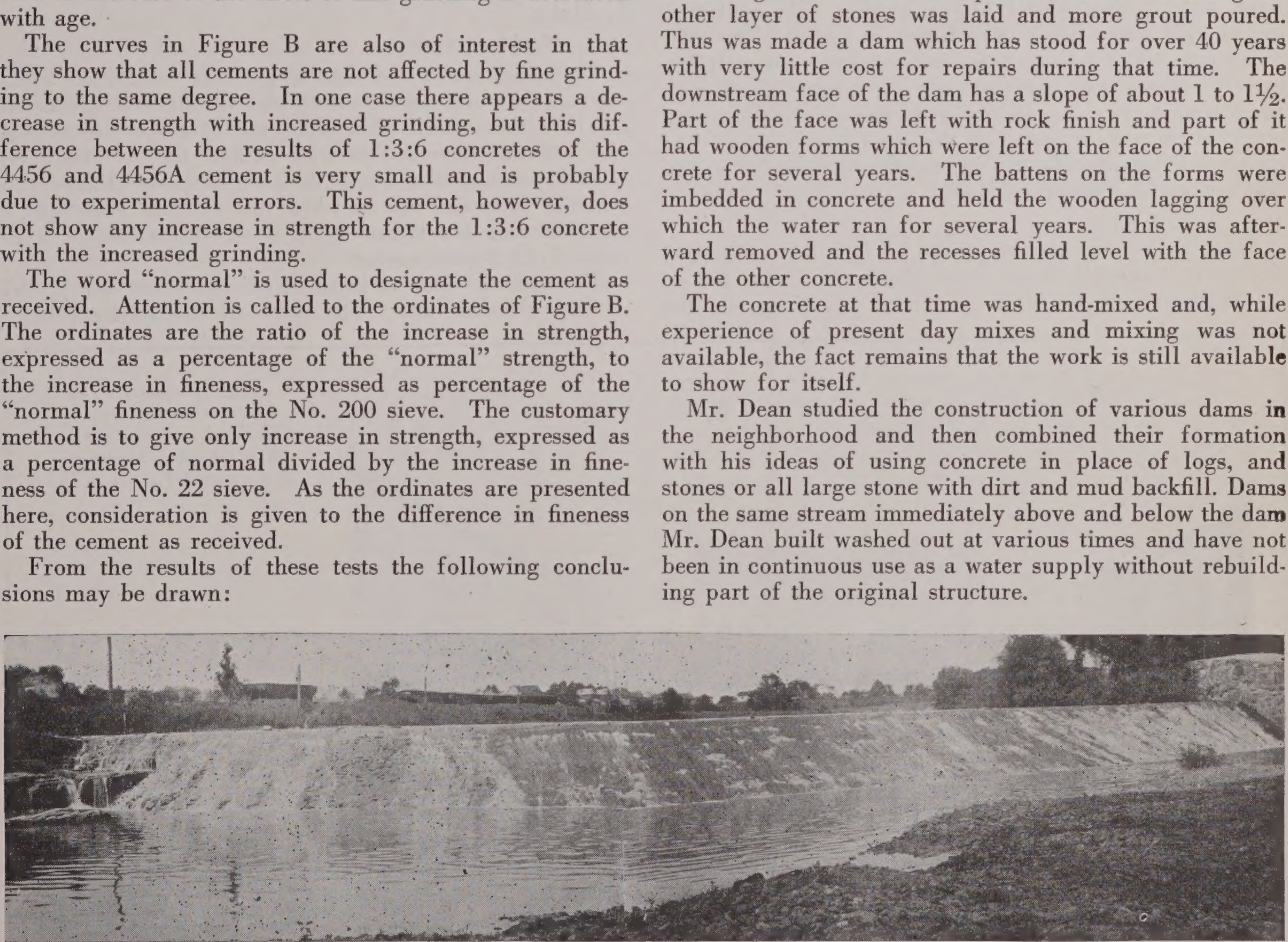
Among other work done that year were 11 houses in which concrete was a part of the construction. The dam and houses are today in a good state of preservation. The dam holds water and the concrete work in and around the houses is good. Six of the houses were in a block and had basement and kitchen floors of concrete, as well as porch and steps to porch.

Three other houses had cement floors in kitchen and porches of concrete, and other houses had only a small portion of concrete around the well curb.

In the dam the construction was a layer of stones over which a grout of 1 to 2 was poured, then after filling another layer of stones was laid and more grout poured. Thus was made a dam which has stood for over 40 years with very little cost for repairs during that time. The downstream face of the dam has a slope of about 1 to 1½. Part of the face was left with rock finish and part of it had wooden forms which were left on the face of the concrete for several years. The battens on the forms were imbedded in concrete and held the wooden lagging over which the water ran for several years. This was afterward removed and the recesses filled level with the face of the other concrete.

The concrete at that time was hand-mixed and, while experience of present day mixes and mixing was not available, the fact remains that the work is still available to show for itself.

Mr. Dean studied the construction of various dams in the neighborhood and then combined their formation with his ideas of using concrete in place of logs, and stones or all large stone with dirt and mud backfill. Dams on the same stream immediately above and below the dam Mr. Dean built washed out at various times and have not been in continuous use as a water supply without rebuilding part of the original structure.



Here is the Cyclopean concrete dam built by William Dean in 1881. It is now in the condition shown, and has outlived a generation of freshets that washed out many other dams on the same river

Concrete Houses in Holland

By ARIE KEPPLER
Director of Housing, Amsterdam, Holland

In Amsterdam we have made an experiment with regard to concrete houses with 10 different systems which may be divided into four chief groups:

(1) Monolithic or in situ work; (2) slabs; (3) frames and (4) blocks.

A garden city of 1000 concrete houses is being erected in the neighborhood according to the above mentioned systems and carried out by seven contractors for the municipality under supervision of the housing department.

We expected we could build concrete houses with cigar makers and diamond workers who were out of work. That was a failure. The trade unions in the building trade did not allow us to use these men. Besides they were not fit to work in the building trade. Nevertheless, we have applied some systems without the help of bricklayers; unskilled people have done the rough work under the direction of skilled men.

The most valuable methods we have used are the following:

1. Monolith or in Situ Work

(a). *Korrelbeton* (granulated concrete).

This consists of concrete in situ walls and roofs. The clinker concrete is 10 to 1 (clinker must not pass a ½-in. mesh and all must pass a 1¼-in. mesh). The cement is mixed with water before the clinker is added. The shuttering consists of 4-in. to 3-in. timber frames about 8x2 ft. to 6 ft. interlocked together and the panels fitted with sheet iron trays. The floors are cross-reinforced about every 24 in. and supported on the usual wood centers. The concrete is usually about 6 in. thick and must be roughcast outside and plastered inside.

(b.) *System Kossel.*

This consists of concrete in situ 14 to 1 (cement-gravel and sand) poured between wood shuttering. The outside is roughcast and the inside plastered. Ceilings and flat roofs can be similarly poured and reinforced. In the latest work poles are rammed down into the wet concrete to form cavities in the walls.

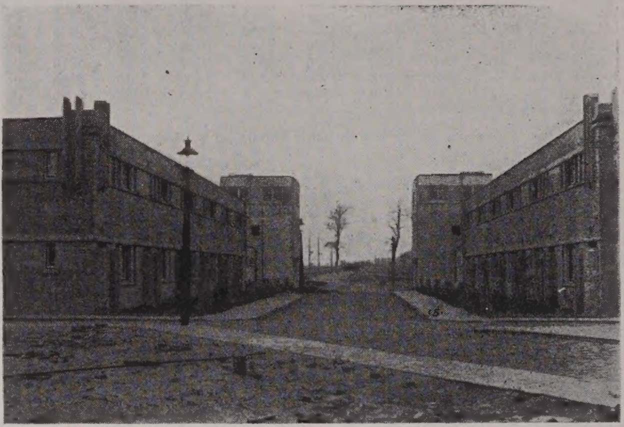


Fig. 5. Houses constructed of concrete block.

This method is satisfactory, but as concrete house construction is a new technical arrangement, it has its defects, of course, but we expect they may be rectified. In my opinion this method has a future.

2. Slabs

(a.) *Occident System.*

The construction consists of pre-cast reinforced walls (6 in. thick) and floors erected in large slabs weighing up to about three tons. The slabs are of three thicknesses. The internal face is laid first with 2 in. of reinforced clinker concrete and a core of 2 in. of loose clinker (no cement) is spread out on which the external face 4 to 1 (gravel concrete) is laid 2 in. thick with a second layer of B. R. C. reinforcement.

The external face is brushed off to expose the gravel on the following day. The slabs are erected by a large

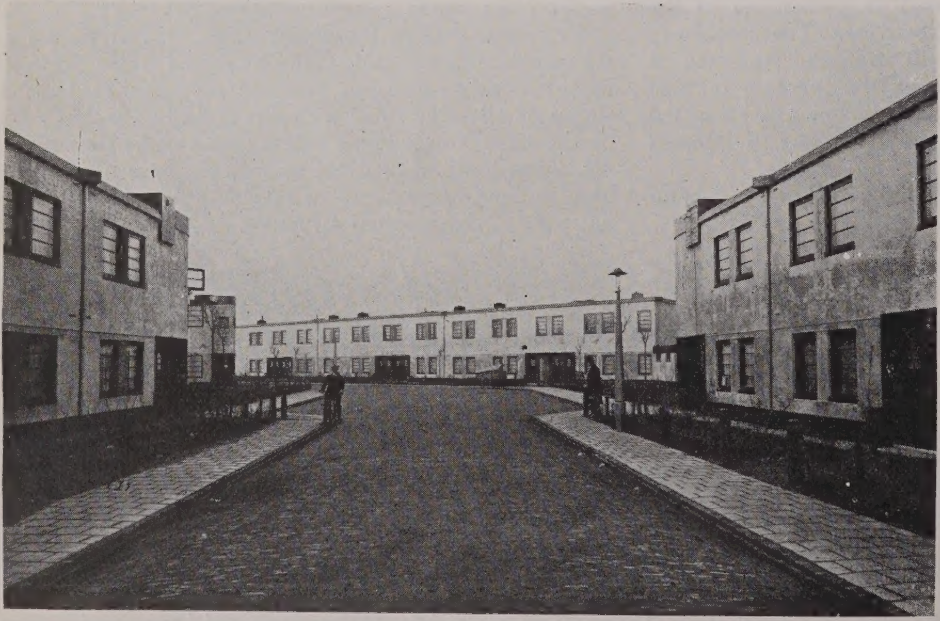


Fig. 1. Concrete house construction in Holland. In situ work, Korrelbeton (granulated concrete).

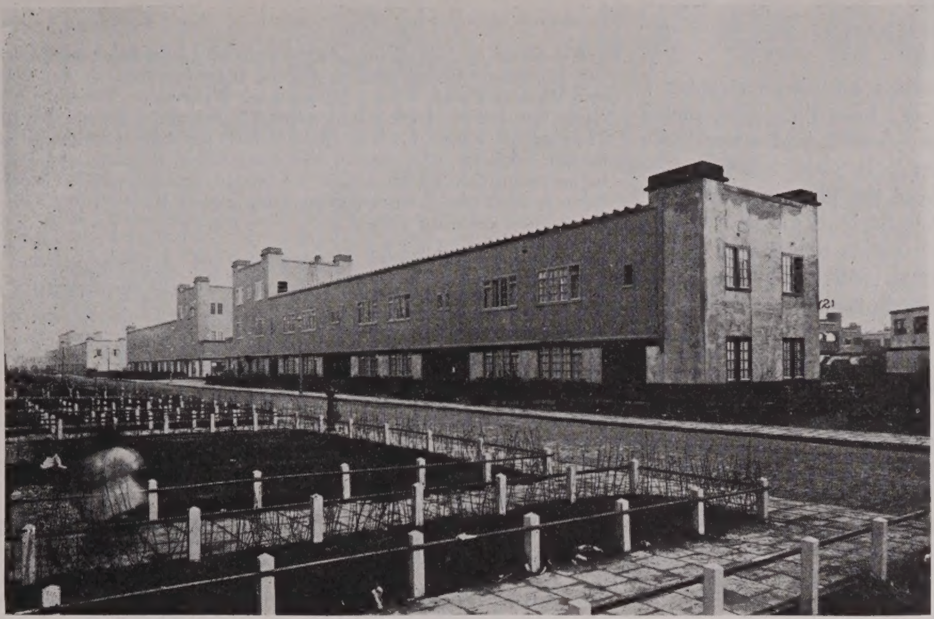


Fig. 2. Slabs system. "Hunckemoller" system using slabs having gypsum cores.

crane and are connected by iron rods passed through eyes projecting from the slabs. Grooved expansion joints are formed with bitumen.

(b.) *Hunckemoller System.*

The cores of the slabs are composed of gypsum and suitable aggregate. This sets in a few minutes and the molds are adjusted so that the external and internal surfaces may be formed around the core. The slabs are finished either with plaster on both sides for partitions or with cement and gravel on external face. The slabs are erected by cranes and jointed with grout. The external surface is rough cast or coated with bitumen and special sand.

This method may also be good, but we must remember, that concrete is a young industry and that it has not, like the brick construction, an experience of 12 centuries.

3. Frame Systems

Timber Frame Houses.

A timber framed skeleton with Mansard roof is erected and the walls are built of half brick externally, backed up with a coat of cement and lined with brick on end.

A concrete shuttering is nothing special; it might as well be a shuttering or filling of bricks. Wooden frames with concrete shuttering will never be satisfactory in my opinion. Iron frames are too expensive for this country.

4. Blocks

This method consists of supplanting bricks by concrete blocks. It will never succeed because it does not convey any new idea for the future and there is no advantage at all; for, in Amsterdam making blocks will never be cheaper than baking bricks and besides this method necessitates bricklayers and masons. We shall not use it any more in Amsterdam.

We expect the technic of concrete will still improve and then it may have many advantages; houses may be erected quicker, they may be stronger and, of course, more durable.

A great part of the concrete village is now finished and we are making tests as to transmission of heat and sound as well as condensation. I cannot yet make up my mind about the results.

The price of concrete houses goes up and down with the price of brick houses just as the price of sand lime stone follows the price of ordinary bricks.

Since we started building concrete houses the contractors and bricklayers have been very anxious, and so, by building concrete houses we have had an influence upon the price of brick houses.

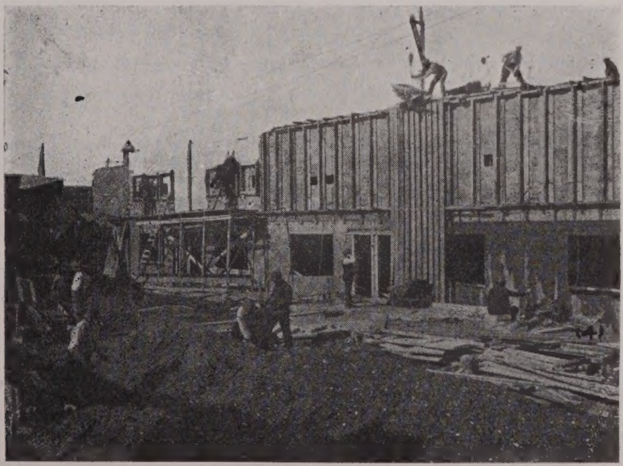


Fig. 4. Constructing a concrete house with timber framed skeleton

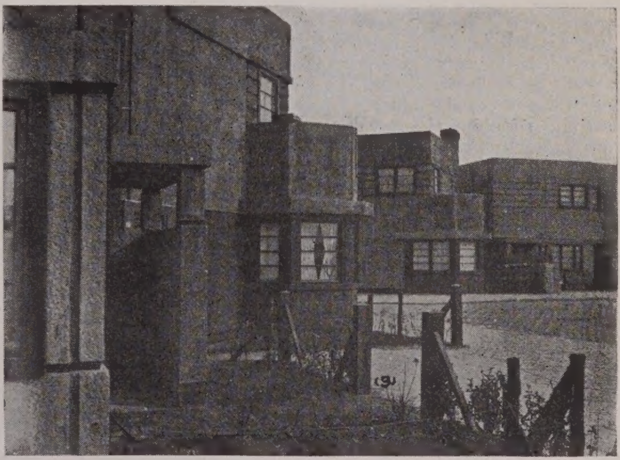


Fig. 3. Another building built after the "slabs" system

Clean Tools Promote Efficiency

By EDWARD HAVEN

At the close of each day's work a certain contractor I know turns a hose on and washes clean the pails, metal bodies of his wheelbarrows, hoes, shovels and other tools used in handling cement mortar. It only takes a few minutes' time and he thus prevents the mortar from caking fast and has clean, efficient tools to begin work with the following morning. Barrow bodies or tools that are allowed to become caked and rough with drier mortar or concrete soon get cumbersome and unwieldy to handle and the job is slowed up.

This contractor also washes out his concrete mixer at the end of each job or when it will stand unused until longer than the following morning, as for instance, over Sunday or a holiday. Workmen feel more like working with clean tools and cleaning a barrow body or pail of hard dried mortar is no easy task, so that the few minutes it requires at the end of each day to keep them clean is time well spent as well as a reducer of costs in the end.

Trade Publications

Improvements in lift truck platforms are announced in a circular issued by the Lewis-Shepard Co., 133 Walnut St., Boston, Mass. A feature is the steel legged platform in which the design and construction have been changed.

Fuller's Earth in 1924, by Jefferson Middleton, is a report recently issued by the U. S. Geological Survey, Department of the Interior, Washington. It is an extract from the bulletin "Mineral Resources of the United States, 1924—Part II" as published recently by the same source. This bulletin cites general conditions of the industry during 1924, the occurrence of fuller's earth in the United States, the uses of fuller's earth, history of the industry, production statistics of the years 1917 to 1924 inclusive, and data on the imports and exports of that mineral for the same years. This bulletin may be secured upon application to the Superintendent of Public Documents, Government Printing Office, Washington, D. C.

The Comparative Bonding Strength of Portland Cement Mortar and Portland Cement Mortar Containing 5% Oxychloride of Calcium (CAL) When Used for Brick Work, a report of tests by John R. Lapham, Professor of Civil Engineering, George Washington University, has recently been issued by the Security Cement and Lime Company, Hagerstown, Md. The report also contains a summary of tests on the comparative effect of oxychloride of calcium on portland cement mortars under rapid drying-out conditions. In the report we see that CAL increases the tensile strength of mortars 52.5%, increases the compressive strength 96.5%, increases the bond strength of mortars with Hytex brick 35.6%, and increases the bond strength of mortar with red backing brick 72%.

Along with this bulletin we received a booklet entitled *"How to Use CAL to Make the Best Concrete and Mortar."* This latter booklet contains a lot of information that would be of interest to the contractor.

Brands of du Pont Explosives and Uses to Which They Are Adapted, is the name of a tabulation recently compiled by the E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware. This is a modernization of the older tabulation hitherto issued by that concern and should make a valuable guide for the producer and the contractor. In writing for this chart, ask for *Explosive Service Bulletin,* July, 1925, wherein this tabulation has been published.

The Foote Bros. Gear and Machine Co., 215 N. Curtis St., Chicago, have just sent out a folder describing the use of IXL Speed Reducers as "built-in" units on modern machinery and equipment. It contains information of interest to the producer, and will be sent upon application to the manufacturers.

The Sterling Builder, published by the Sterling Engineering Co., Los Angeles, California, has just made its appearance in the growing field of consumer house organs. Vol. 1, No. 1, contains several pages devoted to Sterling Tile and Sterlingbilt homes, showing how a modern "detached apartment" may be built at an extremely low cost by means of the new concrete tile. The investment feature of the new tile, together with the manufacturing opportunities, is played up in this first issue. From the contents of this new organ the reader gets the idea that Sterlingbilt Homes may turn out to be the Fords of the home building industry. The new house organ, published at 2320 Ocean View Ave., Los Angeles, will be sent free to anyone interested.

We Stand by Our Colors, is the title of a new color card describing Ricketson Brand Mortar Colors, manufactured by the Ricketson Mineral Paint Works, Milwaukee, Wisconsin. These colors include red, brown, buff, double-strength chocolate, green, and black. They are designed for use in affording permanent color in brick, mortar, concrete, tile, stucco, and composition flooring, and are said to be manufactured by a new air floated process which "assures a velvety, flour-like fineness, greatly adding to their penetration and consequent coloring value."

Associated General Contractors of America, Inc., has issued in handy pamphlet form its code of ethical practice, under the title, *Skill, Integrity and Responsibility.* The code is prefaced in the pamphlet with a statement by the A. G. C. Committee on Ethics.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 1807 East Grand Blvd., Detroit.

American Concrete Pipe Association; M. W. Loving, Secretary, 111 West Washington St., Chicago.

American Engineering Standards Committee; Dr. P. G. Agne, Secretary, 29 West Thirty-ninth St., New York City.

Associated General Contractors of America; G. W. Buchholz, Secretary, 1038 Munsey Bldg., Washington, D. C.

Associated Metal Lath Manufacturers; 123 West Madison St., Chicago; Wharton Clay, Commissioner.

Building Officials Conference; Frank Burton, President, J. F. Downey, City Hall, Cambridge, Mass., Secretary.

Concrete Reinforcing Steel Institute; M. A. Beeman, Secretary, 160 North La Salle St., Chicago.

Iowa Cement Stave Silo Association; H. E. Kilmer, Secretary, Oskaloosa, Iowa.

Iowa Concrete Products Association; Ross Dowell, Secretary, 405 Hubbell Bldg., Des Moines.

Mid-West Concrete Products Association; D. R. Donlen, Secretary-Treasurer, 4340 Marcy St., Omaha, Neb.

National Association of Manufacturers; John E. Edgerton, President; Henry Abbott, Treasurer; George S. Boudinot, Secretary, 50 Church St., New York City.

Ohio Concrete Products Association; G. M. Friel, Secretary-Treasurer, 2284 North High St., Columbus, Ohio.

National Crushed Stone Association; A. P. Sandles, Secretary, 405 Hartman Bldg., Columbus, Ohio.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 East Twenty-second St., New York City.

National Sand and Gravel Association; T. R. Barrows, 903 Munsey Bldg., Washington, D. C., Secretary.

The National Lime Association; Mather Bldg., Washington, D. C. Acting Secretary, 903 Munsey Bldg., Washington, D. C.

Portland Cement Association; William M. Kinney, General Manager, 111 West Washington St., Chicago.

Wisconsin Concrete Products Association; D. R. Collins, Secretary-Treasurer, Milwaukee.